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Colour for Structures in the Landscape

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A major design study submitted for
the Diploma in Landscape Architecture
at Lincoln College, Canterbury, in
November 1978.

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The author wishes to acknowledge the assistance given by a large number of people to this study. It is through their efforts, that a better understanding of colour for structures in the New Zealand rural landscape, may develop.

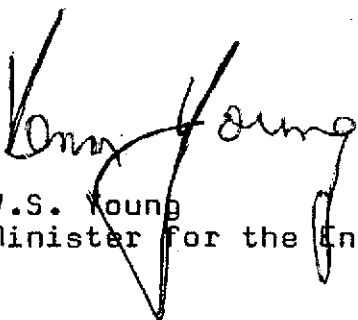
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At the Physical Environment Conference, held in May, 1970, the rural landscape was a frequent topic for discussion. Contributions ranged from a substantial paper urging the development of a national design sense, to suggestions for better planning and to pleas for the removal of hoardings from the rural scene. There was a general consensus that the 'pioneering' era had ended and that both the rural and urban scene needed more aesthetically sensitive treatment.

It was pointed out that sporadic development on rural highways often tends to disfigure the rural environment; that views are marred by "wirescapes" by structures for television and electricity transmission which do not blend with their surroundings, and by derelict trees and farm buildings. Recommendations were passed which called for suitable design standards to ensure that buildings and other structures do not detract from aesthetic values, and which sought the provision of advisory services to the farming community for rural landscape planning. The scope for improving colour schemes was noted.

There has been progress since 1970. New Zealand Railways have progressively reduced the number of rural hoardings. Through the influence of the Nature Conservation Council, transmission lines are sited more appropriately and structures painted in colours more in tune with the landscape.

Nonetheless, I welcome this practical guide. As the author correctly highlights, rural structures of the past were built from local materials and were generally of a smaller scale than now. Current farming technology and the demands of energy production and transport networks require structures which are more intrusive into the landscape. I am confident that this publication will be of benefit to architects, designers, planners, farmers and the community in general.



V.S. Young
Minister for the Environment

November, 1978.

The design of any man-made structure in the rural landscape involves making a conscious design decision as to its surface colour.

In the past, structures such as houses, farm buildings and bridges often assimilated the colour of the surrounding landscape because they were built from local materials. Even materials which were not indigenous to the area have subsequently weathered and have established an empathy with the landscape.

On the other hand, modern structures rarely reflect local eccentricities. Mass produced components and prefabricated structures appear to display only a common utilitarianism which is evident throughout the nationally distributed market. In addition, changes in methods of farming combined with a growth in technology as applied to the agricultural and building industries has made it possible and necessary to erect larger scale buildings in the rural landscape than has been traditional. Such buildings, being more industrial in scale than rural, present visual problems, particularly as the majority have been constructed at minimum capital cost.

This study accepts the inevitability of these changes. Structures are needed at a cost which can be afforded. Building flexibility is required to accommodate specialised skills which will change due to improved techniques. But since the rural environment has become increasingly a place of visual and recreational enjoyment for most New Zealanders, it is important to investigate means whereby the visual impact of these man-made structures is minimised, or alternatively, whereby the impact can be used to enhance the existing rural landscape.

One practical means of controlling the impact of structures in the rural landscape appears to be by an effective use of surface colour. It has become apparent however, that there is little information available concerning the choice of surface colours on structures. That deficiency led to this study.

Any study of this nature has obvious application to many different groups of people. These include farmers, designers, planners and manufacturers. Each group has its own requirement for specific technical information. This communication problem has had to be resolved in the presentation of the study. Therefore, it was decided to divide the material produced into three parts, each having a predominant significance for a major user group.

Part 1 : "Colour for Structures in the Landscape : Colours of the New Zealand rural landscape."

Colours were derived from the rural landscape. A limited range of the predominant colours throughout rural New Zealand were then weighted for seasonal vegetation changes and the likely occurrence of buildings etc. Only in this general way, could a useful range of compatible colours be produced for the national manufacturing market.

Part 2 : "Colour for Structures in the Landscape: A design guide to the use of colour in the New Zealand rural landscape".

This part gives emphasis to colour use by the lay-user. It describes fundamental principles for an effective use of colour particularly on buildings. It also makes the important distinction between 'accent' and 'compatible' colours and their uses in different situations.

Part 3 : "Colour for Structures in the landscape: A methodology for colour derivation in the New Zealand rural landscape."

This part describes for designers and planners, the way in which colours were selected and collated in this study. It therefore suggests a framework within which specific area and project studies can be conducted.

It will be seen that no one part is fully independent of the others. For example, a colour may be selected from the general manufacturers' range specified in Part 1 because it is appropriate to a specific site. But the manner in which that colour is used is subject to the broad principles of colour use outlined in Part 2.

Further, where a structure has, or is likely to have a reasonable visual impact, it is recommended that an independent colour analysis is made for that specific landscape. The methodology for such an analysis is described in Part 3.

As a final introductory comment to the total study it should be stressed that the findings give only a general guidance as to the range of colours existing in the rural landscape of New Zealand. There is no one general colour range which will cover every specific landscape type. On the other hand, the range offered will minimize many of the existing and potential intrusions in the countryside.

FOREWORD

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Colour for Structures in the Landscape

Part 1.
Colours of the New Zealand rural landscape

Studies in the field of visual perception indicate that the colour relationship between the landscape and a proposed structure is a 'target and background' situation. It was decided therefore, that the commencement of the project must be a study of the 'background' or landscape colours. An analysis of the visual problem identified the components involved.

First; vegetation colour and the seasonal changes throughout the year.

Second; surface geology colour and the area of soil visible due to agricultural activity throughout the year.

Third; the effect of changes of the characteristics of incident daylight and sunlight on the colour appearance of the landscape.

A field study was conducted throughout the North and South Islands in October when spring colours in the vegetation were predominant. Daylight conditions were noted and the time for each colour reading was recorded so that the angle of incident light would be known.

The areas selected for study were based on the 'New Zealand Atlas' (1) which indicates soil distribution, land classification and land use.

(1) Ian Wards, ed.
New Zealand Atlas
(Wellington :
Government Printer,
1976) p 138-143

Because of the variety of agriculture, the diversity of vegetation not indigenous to each area, and the distribution of building materials throughout New Zealand, it was decided that the subject could only be satisfactorily treated initially at a national scale, although there are some areas with specific colour preferences, such as coastal or alpine zones.

As the survey was concerned with the colour relationship between relatively large structures and their background it was necessary to limit it to the colour appearance of the countryside when viewed at the medium to long distance. From this viewpoint the individual colours of plants, leaves and flowers merge into an overall appearance which has a minimum texture and presents an area of uniform colour.

The procedure generally follows that described in an equivalent study entitled "Colour finishes for Farm Buildings." (2)

(2) Farm Building
Advisory Committee
Report to the
Design Council,
Colour finishes for
Farm Buildings
(Design Council,
revised May 1975).

But for more specific detail, refer to Part 3 of this study.

(3) British Standards Institution, Draft for Development, "Basic Range for the Co-ordination of Building Colours," BRE Digest 149 (HMSO, January, 1973).

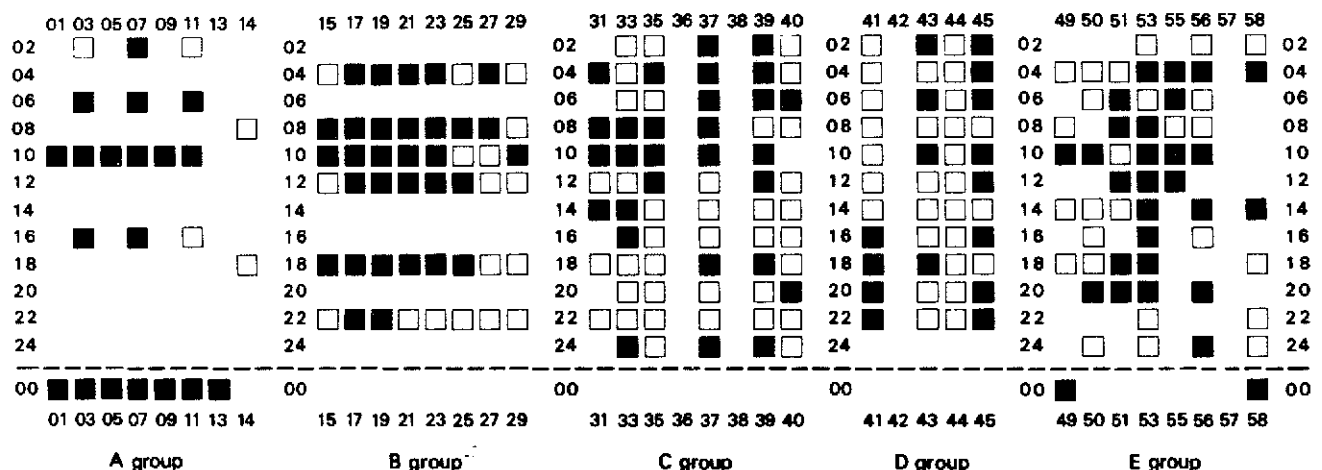
(4) British Standards Institution, BS5252:1976 'Framework for colour co-ordination for building purposes', London: HMSO

In 1972 the British Standards Institution published a Draft for Development (DDL7) entitled 'Basic Range for the Co-ordination of Colours for Building Purposes' (3)

From this framework, eighty eight colours were selected to form the colour standard, BS4800 which superseded BS 2660 in January, 1973.

Since 1972, the draft (DDL7) has been amended and finally modified to form a new standard, BS 5252 : 1976, 'Framework for colour co-ordination for building purposes' (4) which served as a basis for this study.

BS 5252 : 1976, 'FRAMEWORK FOR COLOUR CO-ORDINATION FOR BUILDING PURPOSES'



The framework of BS 5252 is shown above. Colours are organised along the three parameters of HUE, GREYNESS and WEIGHT.

The standard consists of a framework within which 237 colours are systematically related to each other in terms of the three visual attributes, 'hue', 'greyness' and 'weight'. (Note that these terms are used in the operative BS 4800, British Standard Colour system and should not be confused with the Munsell terms, 'hue', 'value', and 'chroma' used in the withdrawn BS 2660, British Standard Colour System).

HUE

HUE is the colour attribute of redness, yellowness, blueness etc.

The framework has twelve horizontal hue rows in spectral sequence plus a further row of neutral colours (i.e. without hue). They are designated by two numerals ranging from 02 (red purple) to 24 (purple).

GREYNESS

GREYNESS is the estimated grey content of colours.

The framework divides the colours into five groups lettered A to E, representing steps of diminishing greyness. For example, Group A is grey; Group B nearly grey; Group C, grey/clear; Group D, nearly clear; Group E, clear.

WEIGHT

WEIGHT is a subjective term for lightness, modified as necessary to produce colours of the same character in different hues.

The framework provides up to eight columns of colours of equal weight in each greyness group. In fact there are 38 columns shown of equal weight. Columns are numbered from the lefthand column of A group (01) to the righthand column of E group (58).

The visual attribute of weight is especially significant to the use of colours in the rural landscape. This is because the weight of a colour describes its ability to reflect light, therefore it is worth mentioning here that generally colours of equal weights will not contrast in reflectivity, because each has the same reflectivity. But this is not always so. In A, B and substantially C greyness groups, columns of equal weight have equal lightness. In greyness groups D and E, however, equal weight requires modifications of lightness in some columns. Reflectivity is discussed in greater detail below.

COLOUR NOTATION

Each colour is identified by a code which indicates its position in the framework. The code consists of three parts the first signifying Hue; the second Greyness; the third Weight.

Hue is signified by an EVEN NUMBER with two numerals, e.g. 02, 04, 24 etc.

Greyness is signified by a LETTER e.g. A, B, C, D, or E.

Weight is signified by a NUMBER with two numerals, e.g. 07, 19, 58 etc.

Example: 10 B 29 : Hue row 10, Greyness group B Weight column 29. Colours of the same row, or greyness group or weight column have the same respective colour attribute.

Appendix A of BS 5252 : 1976, (5) relates the approximate Munsell references to the above notation.

(5) *ibid*

VISUAL ATTACHMENT

The purpose of Part 1 of this study is to select and present colours from the British Standard Range which approximated colours found in the New Zealand rural landscape. Once these are known the colours of a proposed structure (target) can be selected to establish a 'colour attachment' with the landscape (background). Therefore the visual impact may be minimised or if required, maximised.

To attain visual attachment by colour alone, the visual characteristics of hue, greyness and weight for the target must be compared with the same characteristics for the background.

REFLECTIVITY

It has been found by experiment and when viewing a structure in the middle/long distance, that the most important colour characteristic is weight. The weight of a colour determines its light reflectivity. The contrast between the target and background and therefore the geometric outline definition of a structure, is determined by the difference in light reflectivity between the surfaces of the structure and their surroundings.

The light reflectance of a colour can easily be determined by referring to Appendix A, BS 5252 : 1976. This gives the Munsell terminology which classifies colours in terms of hue, value (lightness) and chroma. This terminology is shown enclosed in the boxes. But the correlation with the new hue, greyness, weight system is only an approximation and therefore should be treated with discretion. Reference is made to the Munsell system because the 'Value' characteristic can be used to give an approximate estimate of the reflectance (R) of each colour as a percentage, by substituting the 'value' figure (V) in the formula $R = V (V-1)$. e.g. the 'value' figures in the Munsell references 2.5GY 6/8 and 5GY 7/11 are 6 and 7 respectively, which substituted for V in the formula give approximate reflectances of 30% and 42%. As a general rule a LOW value number (theoretically ranging from 1 to 10) will give a relatively low reflectivity and a HIGH value number will give a relatively high reflectivity. Incidentally, because of the proximity of light and heat radiation in the electromagnetic spectrum, the same percentage reflectance indicates the approximate ability of each colour to reflect/absorb solar heat energy. Thus the designer has an indication of the thermal consequences of his colour choice.

$$R = V (V-1)$$

It was observed that the spring colours predominating in the New Zealand rural landscape lay in the low/middle range of reflectivity (weight) from 2 to 30 percent, the greatest number being in the B & C greyness groups.

Some colours of low greyness create too great a degree of contrast in most landscape situations and it is notable that most colours occurred in the middle greyness groups. However, very dark colours of low greyness could also be acceptable. Two colours of low greyness were therefore included in the selected range. Other strongly contrasting colours (accent colours), may be used discreetly by skilled designers to good effect.

CAMOUFLAGE COLOURS/COMPATIBLE COLOURS

All three variables of hue, greyness and weight will change with the seasons and daylight and sunlight characteristics. The selection of colour must take into account these transient features. It is therefore not possible to achieve a high degree of camouflage. Near miss matches are likely to create a visual ambiguity which is unacceptable.

In this study emphasis has been put on comparing the reflectivity of colours so that families of hues adjacent to those predominant in the landscape can be selected. Therefore, a family of colours is created and these can be used happily together. 'Compatibility' rather than 'matching' is the key notion.

TIME OF SURVEY

The range of colours in the landscape changes seasonally but also during the day due to variation in natural illumination, temperature and textural effects.

As mentioned previously, the field of survey for this study was carried out at selected sites in the North and South Islands of New Zealand during October, 1978. The data collated is for Spring colours. Because each sample would vary to a greater or less degree seasonally and under different light conditions, the selected range of colours is therefore weighted to try and accommodate this variability. It is also weighted according to the likelihood of structures being built on particular sites. Part 3 of this study gives more detail on this aspect

Wall Colours



04D44
Flamenco



08B25●
Cork



08C37●
Hot Curry



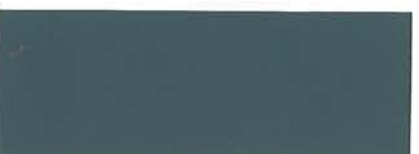
10B21●
Granite Green



10D45●
Yukon Gold



18B21●
Oslo Grey



18B25●
Trout



20C37●
Kashmir Blue

Roof Colours



04B29
Carmine



04C39
Scoria



08B29●
Cuban Tan



10B27
Army Green



12B27
Karaka



18C39●
Nile Blue

Notes.

All colours are selected from the BS5252 range and those marked with a dot, are included in the BS4800 range.

Accent colours, suitable for gutters, windows, doors and other small areas may be added to this range.

(6) Farm Building
Advisory Committee
Report to the
Design Council,
Colour finishes for
Farm Buildings
(Design Council,
revised May 1975).

In the British publication, 'Colour finishes for farm buildings,' (6) reference is made to farm buildings traditionally having roof material which is darker than the walls. In New Zealand we have no such tradition, as the typical corrugated iron structure presents walls and roof of the same material.

Roof and walls are typically finished in the same colour or in the integral material colour. Because of the varying incident angle of sunlight and the textured surface of corrugated iron, the light reflectivity off the roof is in many instances greater than off the wall frequently giving it a lighter appearance.

This variable relationship presents a difficult visual situation. In overcast, grey conditions the daylight tends to be diffuse. The form of the structure becomes ambiguous because of lack of architectural definition between roof and wall planes.

Therefore, the selected range of colours is broken into two groups; one for wall surfaces and one for roof surfaces. The roof surface colours selected are darker as it is felt that the darker horizontal roof plane is more effective in identifying the building to its site and therefore its landscape setting. A lighter roof tends to blend with the sky colour leaving the darker and distinctively geometrical wall shapes to contrast with the natural forms of the site.

A minimum reflectivity difference of 10 per cent between roof and wall planes is selected to give architectural definition when the structure is viewed in the middle to far distance.

WALLS

04 D 44
08 B 25*
08 C 37*
10 B 21*
10 D 45*
18 B 21*
18 B 25*
20 C 37*

ROOFS

04 B 29
04 C 39
08 B 29*
10 B 27
12 B 27
18 C 39*

NOTE

(1) Colours marked with an asterisk are in the BS 4800 range

Table showing roof/wall combinations

WALL COLOURS								reflectivity %	
20	12	30	20	30	20	12	12	reflectivity %	
20 C 37	18 B 25	18 B 21	10 D 45	10 B 21	08 C 37	08 B 25	04 D 44		
●	●	●	●	●	●	●	●	04 B 29	2
●		●	●	●	●			04 C 39	6
●	●	●	●	●	●	●	●	08 B 29	2
●		●	●	●	●			10 B 27	6
●		●	●	●	●			12 B 27	6
●		●	●	●	●			18 C 39	6
		●		●				08 B 25	12
		●		●				18 B 25	12



Roof 08B29 Cuban Tan
Wall 18B25 Trout



Roof 18C39 Nile Blue
Wall 18B21 Oslo Grey



Roof 08B25 Cork
Wall 18B21 Oslo Grey



Roof 04B29 Carmine
Wall 08B25 Cork



Roof 18C39 Nile Blue
Wall 10B21 Granite Green



Roof 08B25 Cork
Wall 10B21 Granite Green



Roof 04B29 Carmine
Wall 10D45 Yukon Gold



Roof 18C39 Nile Blue
Wall 20C37 Kashmir Blue



Roof 10B27 Army Green
Wall 20C37 Kashmir Blue



Roof 04B29 Carmine
Wall 08C37 Hot Curry



Roof 18C39 Nile Blue
Wall 08C37 Hot Curry



Roof 10B27 Army Green
Wall 10D45 Yukon Gold



Roof 18B25 Trout
Wall 18B21 Oslo Grey



Roof 08B29 Cuban Tan
Wall 08C37 Hot Curry



Roof 10B27 Army Green
Wall 08C37 Hot Curry



Roof 12B27 Karaka
Wall 10B21 Granite Green



Roof 04B29 Carmine
Wall 04D44 Flamenco



Roof 04C39 Scoria
Wall 18B21 Oslo Grey



Roof 12B27 Karaka
Wall 18B21 Oslo Grey



Roof 04B29 Carmine
Wall 18B21 Oslo Grey



Roof 04C39 Scoria
Wall 10B21 Granite Green



Roof 12B27 Karaka
Wall 10D45 Yukon Gold



Roof 04B29 Carmine
Wall 10B21 Granite Green



Roof 04C39 Scoria
Wall 20C37 Kashmir Blue



Roof 12B27 Karaka
Wall 08C37 Hot Curry



Roof 04B29 Carmine
Wall 20C37 Kashmir Blue



Roof 04C39 Scoria
Wall 10D45 Yukon Gold



Roof 12B27 Karaka
Wall 20C37 Kashmir Blue



Roof 04B29 Carmine
Wall 18B25 Trout



Roof 04C39 Scoria
Wall 08C37 Hot Curry

The vast majority of structures in the rural landscape are erected without specialist design advice in the use of form or colour. The greatest number of such structures are farm buildings, designed on the factory floor leaving only a minimum site preparation before prefabricated components are assembled.

FARMERS

It is hoped that this simple method of choosing colours will be of practical assistance to farmers as well as the manufacturers of components. Where farmers generally require colour to be integral in order to reduce maintenance costs, they now also have the advantage of being able to select from a growing range of factory finished colours of cladding. Where buildings are already existing and require painting for maintenance, the range of colours derived in this study should be of assistance. Part 2: 'A Design Guide to the User of Colour in the New Zealand rural landscape' may be of further assistance.

SPECIALIST DESIGNERS

It is recognised that specialist designers will be able to devise different and successful colour schemes for specific sites. This study on the other hand is designed to try and accommodate the needs of the majority situation and prevent some of the ill-considered intrusions in the rural landscape. In all cases where the proposed structure is likely to make a major visual impact specialists in landscape architecture, architecture or industrial design should be consulted.

MANUFACTURERS

It is not expected that all manufacturers will produce the entire range of colours. Although the New Zealand market is relatively small, the wide use of some building components justifies consideration in the use of factory applied or integral colour. For the manufacturers, the suggested range is a guide to the colour already existing in the rural landscape.

PLANNING AUTHORITIES

The choice of colours in the selected range is relatively wide. Not all colours are appropriate to each Region or District. Where planning authorities wish to complement local characteristics through the use of colour, the selected range should, in general, give them satisfactory results provided that the recommended method of choosing combinations of colours is followed. It should be emphasised that the suggested range is not intended to be comprehensive, but may provide a basis for discussion and modification in each particular locality.

Part 2 of this study, may give further assistance to users of colour on structures in the rural landscape.

Colour for Structures in the Landscape

Part 2.

A design guide to the use of colour in
the New Zealand rural landscape

2

A DESIGN GUIDE TO THE USE OF COLOUR IN THE
NEW ZEALAND RURAL LANDSCAPE.

INTRODUCTION.

This part of the study considers the use of colour on structures in the rural landscape. It takes the point of view of the user. In most cases this will be the farmer or farm manager. The principles outlined are straightforward and are intended to apply to those general situations where design information is not already available.

In the past, the selection and application of colour to structures has been largely subjective. There are nevertheless, strong visual and practical guidelines which can be followed. These guidelines are not an alternative to the individual's emotional responses to, or preference for particular colours. On the contrary, they may be of some help in colour selection by first, locating personal preferences within a landscape context and second, by indicating how those preferences can most effectively be used to satisfy design intentions. But in general, the guidelines give a rational base for the selection of colours for structures in the rural New Zealand landscape.

VISUAL ATTACHMENT.

The single most important visual consideration in selecting a colour for a structure, is the visual relationship between that structure and its landscape background. This relationship is described as the 'Visual Attachment' of a structure to its background.

Colour itself cannot be considered in isolation. There is a range of visual cues which determines the degree of visual attachment. For structures, six of the most important are;

1. Colour of surfaces.
2. Texture of surfaces.
3. Scale of structure.
4. Shape, form and profile of structure.
5. The directional effects of surface pattern and shadow.
6. The subdivision of building surfaces by windows, doors, openings etc.

The natural landscape also has visual cues, which relate to those listed above. It is because of this set of relationships, that the visual attachment between any structure and its background, can be manipulated. For example, a structure can be visually modified to be compatible with its background and present a relatively low impact. Alternatively it can be modified to provide contrast in a landscape deficient in visual interest.

Some of the cues must be briefly discussed before a closer look can be taken at the use of colour as a design tool.

TEXTURE AS A VISUAL CUE

Texture dominance varies with distance. For example, looking at a tree from a few metres, the texture of leaf patterns is dominant. From one hundred metres, major branches form the dominant texture. From several hundred metres entire groups of trees become the dominant texture. This is because texture decreases in scale with distance.

We are concerned, however, with buildings at that distance where they form an important component in the general visual scene. This is the middle distance where most landscape surfaces have a small scale texture. Surfaces at this distance appear matt, with the exception of water, the surfaces of which vary from a high gloss under calm conditions to matt, when the water is disturbed. Therefore, it could be stated that in the majority of situations, the landscape gives an overall matt appearance.

SCALE AS A VISUAL CUE

'Scale' is a relative measure of dimension. The scale of buildings, spaces and surfaces, are frequently related to human dimensions. Our interest here, is to also relate the structure to the scale of the landscape, when the structure is seen in the middle distance.

The scale of subdivision of the agricultural landscape in New Zealand, as distinct from the uncultivated mountain, bush and forested regions, is moderate to large. For example, in the undulating countryside of South Canterbury the scale is generally moderate. On the alluvial plains of Canterbury, the scale is large.

Structures usually contribute small scale elements to a larger scale background. However, the use of large scale farm buildings, such as woolsheds with covered yards and structures associated with intensive agricultural techniques, is increasing. These buildings are frequently larger scale elements than are those elements of the background landscape.

FORM AS A VISUAL CUE

Form is the mass of an object, or a combination of objects which appear unified. If only seen in two dimensions, it is called 'Shape'.

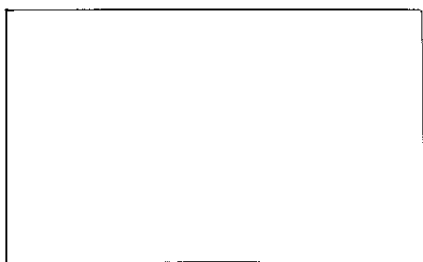
The shape and form of elements making up the landscape are usually organic or non-geometric. Therefore any man-made object will usually contrast with the landscape background because of its geometric form. Such contrasting forms are potential centres of attention.

Structures sited on skylines not only contrast in form and shape, but the geometric outline also interrupts that distinctive edge between earth and sky. Therefore unless it is the design objective to make the structure a centre of visual attention, skylines should generally be avoided.

Where a structure is sited against a landscape background rather than against the sky, there is a greater opportunity to control the negative or positive degree of visual attachment by expressing form with colour. This is because the landscape background is less variable in colour than the sky.

DIRECTIONAL PATTERN AS A VISUAL CUE

The directional pattern resulting from viewing a horizontal plane, regardless of its geometric or non-geometric subdivision, is dominantly horizontal. Therefore if structures have a pronounced horizontal direction, they will have



a 'directional' attachment with their background. In general, structures with a vertical directional effect, will contrast with their background and increase their visual importance in that landscape. For example, the importance of a flag pole as a focus, is in its contrasting verticality. On the other hand, a pole house may blend in particularly well with other vertical elements, such as trees.



Design decisions from visual cues

The identification of the visual cues present in the landscape, as compared with the visual characteristics of the proposed structure, forms a basis for design decisions. These decisions will lead either, to the structure becoming a centre of attention in the landscape or, will result in it tending to merge with its background, that is, becoming compatible with it. The last case is the result of organising the visual cues so that there is a maximum visual attachment.

Firstly, the range of factors concerning the visual design of the proposed structure in the landscape, is established. Then the question of how much it should add or detract from the existing situation must be decided. That decision is based on the visual quality of the existing scene and the proposed structure. In most cases, the judgement of both qualities is straightforward.

Where the structure is simple in form and proportion, has a human scale and is sited with care in the landscape, it can enhance the visual scene. This is especially true in areas where existing visual interest is deficient. If, however, practical considerations require a structure that does not possess these qualities, or which must be located on a visually difficult site, then the appearance of the structure should be designed to disturb the existing landscape as little as possible.

It has already been noted in the Preface that such decisions did not often arise with traditional structures. These for reasons of scale, form, construction and the use of limited local materials, had a considerable degree of attachment with their landscape background. They were usually horizontal in direction and because of the local materials used, had matt surfaces which were not monolithic in colour. This gave those structures a harmonious relationship with their background. Usually therefore, the only contrast factor was that of geometric form.

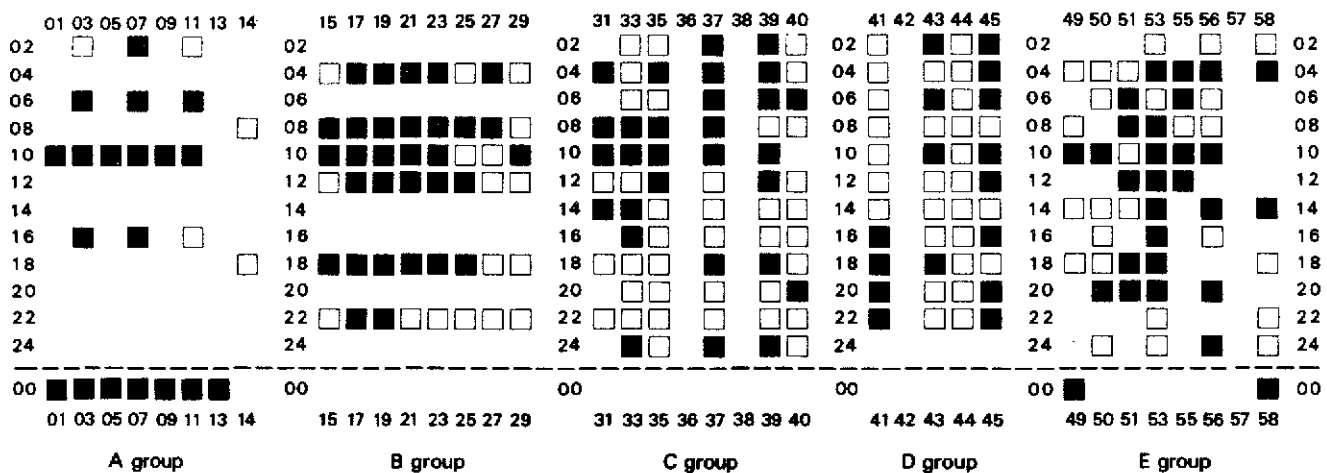
Compared with traditional structures, modern structures are rarely of similar scale, form or construction. Nor would one expect them to be. Methods of farming have changed. Technology has shown a substantial development in both the agricultural and building industries. The wide range of man-made materials now available for cladding, have finishes which are more often glossy than matt and have colours which tend to be homogenous.

Such changes have, therefore resulted in a considerable reduction in the attachment of structures to their landscape backgrounds, so that they often become new and unacceptable centres of attention. It was this situation which led to the investigation of colour as a design tool, to see if it alone could result in an increase of the visual attachment between a structure and its background.

Attainment of visual attachment by colour alone requires the consideration of several colour attributes for first, the landscape background and second, the proposed structure. These include the attributes of Hue, Greyness and Weight as well as the reflectivity for each colour.

The colour system used

The colour system used is described in detail in Part 1 of this study. It is based on the standard BS 5252:1976, the layout of which is shown in the diagram. The colour attributes included are Hue, Greyness and Weight.



The framework of BS 5252 is shown above. Colours are organised along the three parameters of HUE, GREYNESS and WEIGHT.

HUE : 12 horizontal rows in sequence from red/purple at top to purple at bottom, with a further row below the dotted line for neutral colours (neutral greys, whites and black).

GREYNESS : 5 groups in sequence from grey (A group), through nearly grey (B group) grey/clear (C group), nearly clear (D group), to clear (E group).

WEIGHT : provision for 8 vertical columns in each greyness group, graded from lightest on the left of each group to darkest on the right. The colours in each column are adjusted to appear of a similar Weight, i.e. to vary significantly only in Hue.

In addition to the colour attributes described in the colour system, there is one other very important colour property which should be understood. This is the colour's ability to reflect light, or its 'Reflectivity'.

COLOUR AND REFLECTIVITY

1. See Part 3 of this study.

Laboratory experiments suggest that our perception of colour is dependent on each colour's unique ability to reflect more or less light.⁽¹⁾

They also suggest that because we are able to discriminate between different light reflectivities, we are also able to visually perceive the shapes, forms and textures of most objects in light.

It follows that light 'Reflectivity' is important to any consideration of colour or visual perception.

These principles can be used to advantage in design. If the design intention is to make a structure merge with its landscape background through the use of colour alone, the colour reflectivity of the structure must be similar to its background. That colour is known as a 'Compatible Colour'. If, however, the intention is to make the structure, or any part of it, contrast with its background through use of colour alone, the most effective way is to use a colour of contrasting light reflectivity with that of the background. That colour is known as an 'accent colour'. Therefore it is important to establish the reflectivity of the predominant background colour before deciding on a colour for the structure.

But there is another important non-visual reason for establishing the reflectivity of a colour intended for use on a building. Most people are aware that by cladding an object in a material which is light in colour, it will tend to reflect more radiant heat from the sun than will a darker colour. Of course, the same argument holds for the use of applied colour, such as paint. This can be an important consideration especially for such buildings as shearing sheds, or buildings housing poultry. Colours chosen may depend on the heating and ventilation properties of each building design.

What many people probably do not realise, is that the percentage reflectivity of thermal radiation, characteristic to each colour, is approximately the same as the percentage reflectivity of light radiation for the same colour. This is because the thermal and visual characteristics of radiation are adjacent in the Electromagnetic Radiation Spectrum.

By referring to the method outlined under 'Reflectivity', in Part 1 of this study, the approximate percentage reflectivity (R) characteristic to each colour, is found for both heat and light radiation. If either Part 1, or BS 5252 : 1976 (2) are unavailable to the user, there is an alternative way of comparing the relative reflectivities of colours and therefore

2. British Standards Institution BS5252:1976 'Framework for colour co-ordination for building purposes', London, H.M.S.O.

3. Remember that 'Weight' is a scale related to the lightness or darkness of colours and is therefore related to reflectivity. Refer to the diagram of the BS5252:1976 layout. The reflectivity of Hues (horizontal rows) varies from high, (left hand weight column) to low, (right hand weight column), in each greyness group.

establishing their relative abilities to reflect light or heat. Because 'Weight' is the colour attribute related to the lightness or darkness of a colour it is also related to the colour's reflectivity. If the colour is located in Greyness groups A or B (see colour system diagram), every hue in the same weight column has the same reflectivity. This is only generally true for 'colours' located in Greyness group C.(3)

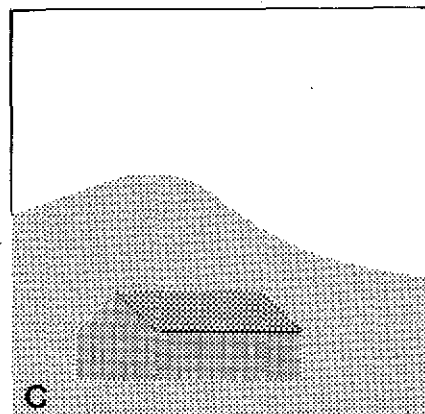
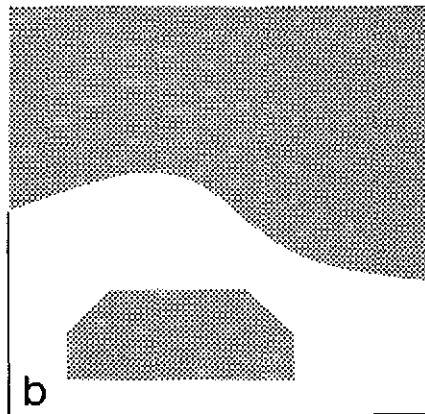
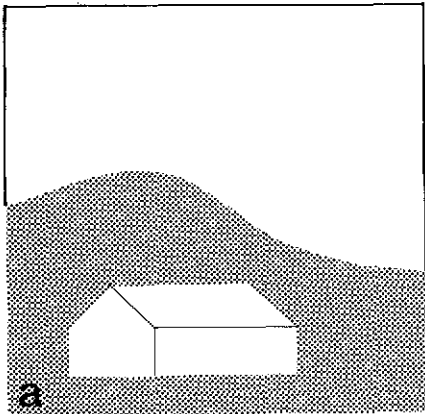
Compatible Colours

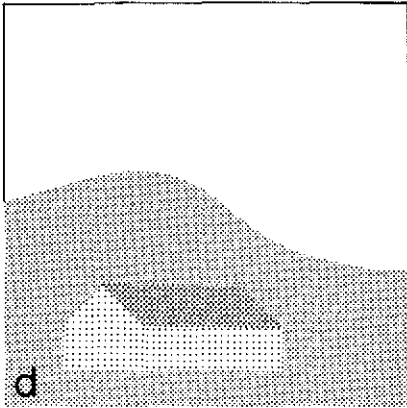
The compatibility of a colour is also largely determined by its reflectivity compared with that of the background. Remember that a 'Compatible Colour', is one used on a structure so that it tends to merge into the landscape background.

Because all three colour attributes of Hue, Greyness and Weight for a landscape will change according to daylight conditions and the season, no one attribute is stable enough to consistently describe the predominant landscape colours. Colour Reflectivity, on the other hand, appears to be more stable and has been identified as a most significant factor in visual perception. Therefore in this study, emphasis has been placed on the relative reflectivity of a structure and its landscape background. For example, when trying to make a structure merge with its background through use of colour alone, it is of prime importance to ensure that the daylight reflected from each is similar. The designer still has almost the complete spectrum of hues (yellow-red, yellow etc.) from which to choose a colour for the structure, as long as the colour chosen, has a similar reflectivity to that of the background colour.

A less important consideration for colour compatibility, is the Hue contrast. The hues listed in this study include the complete colour spectrum and are;

- (02) red-purple
- (04) red
- (06) yellow-red
- (08) yellow-red
- (10) yellow
- (12) green-yellow
- (14) green
- (16) blue-green
- (18) blue
- (20) purple-blue
- (22) violet
- (24) purple





Establishing colour compatibility.

- a. Target highly reflective and contrasts with background. Obtrusive.
- b. Target of low reflectivity and contrasts with background. Visual hole.
- c. Target and background compatible but hard to perceive form. Visual ambiguity.
- d. Target and background compatible. Form easily perceived.

These hues can be diagrammatically depicted in a Hue circle, so that (24) purple, is adjacent to (02), red-purple. Generally, hues further away from each other in that circle will tend to contrast more. Adjacent hues will tend to contrast less.

If however, a designer attempts to pick the same hue for a structure as is predominant in the background, seasonal colour changes will almost invariably result in a near miss-match and visual ambiguity. This is unacceptable.

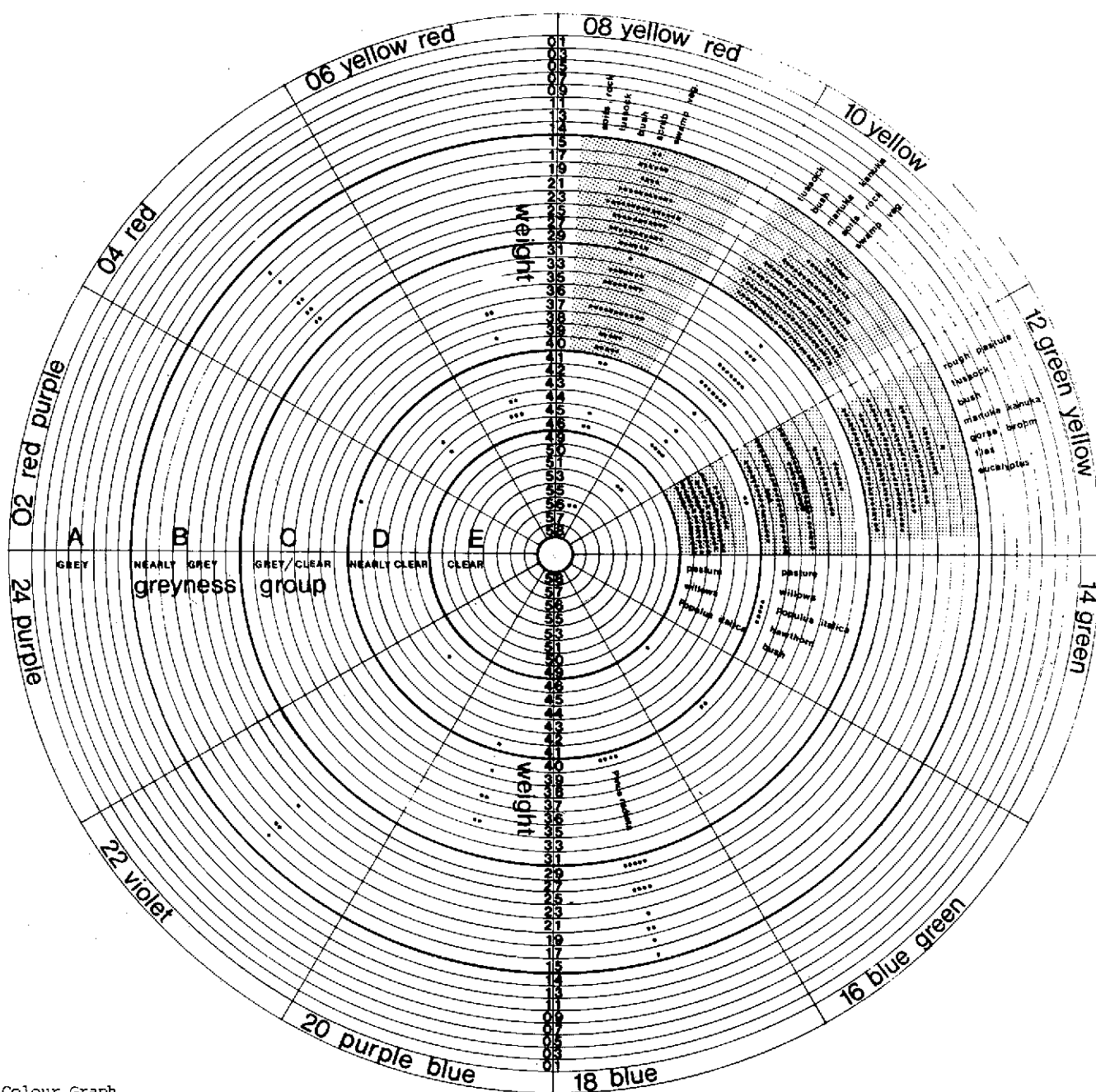
Therefore it is wise to first select colours of similar reflectivity and second, to select hues which are adjacent to those predominating in the landscape background. This will minimise the colour contrast and increase the visual attachment between structure and background. Those colours selected will be compatible colours.

Camouflage Colours

It should be stressed, that no attempt to camouflage a structure is likely to be successful. The landscape background undergoes many seasonal colour changes, as well as colour changes due to the variable character of incident daylight. To camouflage a structure requires many colour changes to it, to correspond with these variations. This is obviously impractical. In addition camouflage colouring is likely to set up a situation of visual ambiguity to a degree which is unacceptable. This study, is therefore, not concerned with camouflage techniques, but with compatibility between colours found in the landscape background and those used on structures seen against that background.

SURVEY OF COLOURS IN THE RURAL NEW ZEALAND LANDSCAPE
Before any colours can be selected for structures, the colours of the background must be known.

An obvious starting point to this study, was to survey the colours generally found in the overall New Zealand rural landscape and to analyse their characteristics. The results of that survey are reported in full in Part 3 of this study



Colour Graph

Colours were taken from the rural landscape and plotted on this graph. Hues are shown around the perimeter. It can be seen that the vast majority of readings are in the (08), yellow-red, (10) yellow and (12), green-yellow bands. Colours in the (14), green hue band, are almost entirely absent.

COLOUR RANGE DERIVED FROM GENERAL SURVEY

The colour range is generally applicable to the rural landscape throughout New Zealand, throughout the year. It is not the only one which will fit specific situations but is designed to be helpful in most landscape types. The range is shown in colour in Part 1 of this study.

Colour design techniques for specific sites

The colour theory, survey findings and the derived colour range discussed so far have all been general in application. It is true that the colour range is designed to be adequate for most rural situations in New Zealand. However, in many cases, users may prefer to design their own colours for specific sites and specific backgrounds. Therefore, an outline procedure and some techniques are suggested to this end.

The derivation of compatible colours from a landscape background

The colour reflectivity of a predominant background colour can be calculated. The background is compared against a colour range of known Hue, Greyness and Weight attributes. Reference is then made to BS 5252: 1976, so that the reflectivity of the comparison colour selected can be calculated by using the formula described therein.

This method although reasonably dependable, is cumbersome and relies heavily on the user's access to BS 5252: 1976. Therefore, alternative methods which do not require calculation are suggested. They require making a colour comparison between a known colour on a colour card with the colours predominant in the background.

There are two helpful 'tricks' when making a colour comparison with a landscape background.

The first is to isolate one colour in the range from the others and the card background, by overlaying a grey card or paper template, so that only one colour is visible at one time. If this is done, the colour matching is likely to be more accurate.



































































































































































































































































































The second 'trick' is to make the colour comparison when your eyes are slightly out of focus. By blurring the vision, less significant detail is avoided, making it easier to see the predominant colours and colour weights. Also, it merges shadows from the textured background into an overall or predominant colour.

Method 1

The first method will give a range of Hues (Yellow, Red, etc.) which can be used on the structure. These will be similar in Greyness and Reflectivity to the background. It is very simple.

The notation used on the BS 4800 range is the same as the notation used for the BS 5252 range.

Take a colour card, such as paint manufacturers issue, to the site. This card must have the BS 4800 notation below each colour. For example, the notation may be, 12.D.45; that is, the coded part for 'Hue' is 12, the coded part for the 'Greyness group' is D, and the coded part for 'Weight' is 45. No other form of colour notation will work.

01 03 05 07 09 11 13 14	15 17 19 21 23 25 27 29	31 33 35 36 37 38 39 40	41 42 43 44 45	49 50 51 53 55 56 57 58
02   	02      	02     	02    	02    
04   	04      	04     	04    	04    
06   	06      	06     	06    	06    
08    	08      	08     	08    	08    
10    	10      	10     	10    	10    
12    	12      	12     	12    	12    
14   	14      	14     	14    	14    
16   	16      	16     	16    	16    
18   	18      	18     	18    	18    
20   	20      	20     	20    	20    
22   	22      	22     	22    	22    
24   	24      	24     	24    	24    
00    	00      	00     	00    	00    
01 03 05 07 09 11 13 14	15 17 19 21 23 25 27 29	31 33 35 36 37 38 39 40	41 42 43 44 45	49 50 51 53 55 56 57 58
A group	B group	C group	D group	E group

12D45 located in range

Try and match a colour on the card with the predominant background colour. It is essential that the same daylight levels are on the card as exist in the middle distance background. One should not be in shadow when the other is not. It is important also that the colour card is held horizontal when the comparison is made.

Once the background colour has been matched, look at the notation for that colour. First look at the middle letter, (the Greyness Group), then the last two numerals, (the Weight).

If the matched colour is in Greyness Groups A or B, then every hue in the same Weight column will have the same reflectivity. If the colour is in Greyness Group C, this is also generally true. Therefore it is possible to find a limited number of different colours of the same reflectivity.

But if the matched colour is in Greyness Groups D or E, then Method 1 is not recommended. In those two groups, colours of equal weight do not necessarily have the same reflectivity.

Assuming that the matched colour is in Greyness Groups A, B or C, (it was found from the landscape colour survey that this is most likely, with the possible exception of a few colours in Greyness Group D), then it is possible to pick a colour for the walls of the same reflectivity as the landscape background.

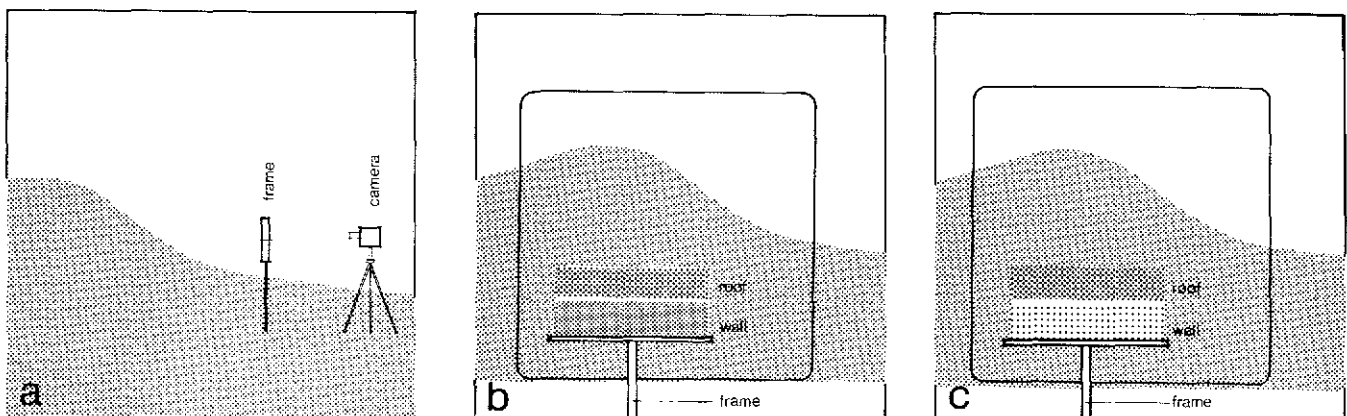
Colour and directional patterns p.37.

With the wall colour chosen, the roof colour selected should be significantly darker. (See 'Colour and Directional Patterns'). Colours of suitable reflectivity will be found for weights 27; 29; 39; 40: Any colour, with one of those weights at the end of the notation code, will have a reflectivity of approximately 2 or 6 per cent. Some of the naturally darker Hues with a 12 per cent reflectivity can also be used but their successful use depends very much on the colour chosen for the walls.

Method 2

The second method will give a colour combination for the roof and walls of a structure. This combination can be made to be compatible or contrast with the background. Again it is simple and does not require calculation. In this method, the colour notation is unimportant.

A frame is taken to the site and set up against the landscape background as shown. Alternative combinations of roof and wall colours are placed in the frame. Each combination is photographed so that the frame and colours show the relative size and location of the proposed structure. Again it is important that the daylight quality on both colours and background be equivalent.



Method 2 for comparing target/background colour compatibility.

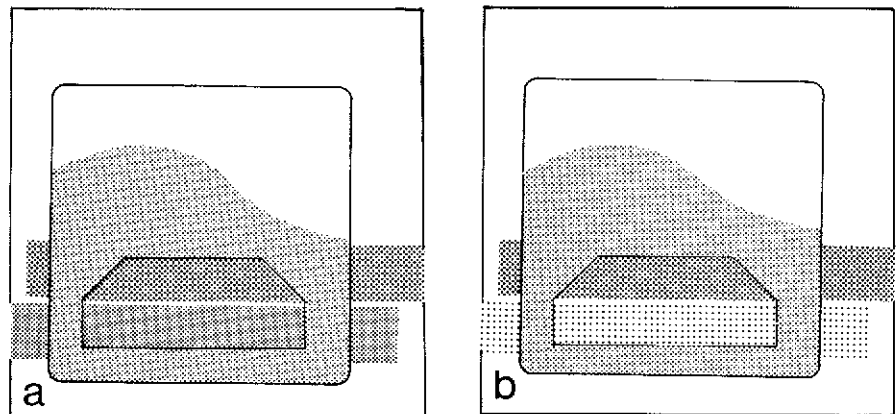
- A frame containing the colours is taken to the site and set up against the landscape. Photographs are taken of alternative combinations of colours.
- Each alternative roof and wall colour is photographed against the background simulating the actual size and location of the building.

Each photograph is then inspected for colour compatibility between the combination colours and the background. Check first that the proposed wall colour is not significantly lighter or darker than the background. If you are designing for compatibility, the 'lightness' of each should be about the same. Then check for Hue contrast. (Red contrasts with Blue, etc). If there isn't too much contrast, then you have a compatible wall colour. Remember that you should not try and exactly match the wall and background colours. It is better to pick a slightly different hue (yellow-red, green-yellow, etc) which has a similar reflectivity.

The requirement to photograph the colour frame against a background is not always necessary but usually it will be a safe practice. The colours of the background will vary with the seasons and therefore, it is desirable if at all possible to repeat this exercise in different seasons. In addition, many structures will be sited so that they have backgrounds significantly different in colour when seen from different vantage points. Therefore the exercise should be repeated for the most important of these. Photographs allow a comparison of each set of results before the colours most suitable to the different backgrounds can be selected. The combination selected should have a darker colour for the roof. (See 'Colour and Direction Patterns').

Method 3

The third method will also give a colour combination for the roof and walls of a structure. Again the combination can be made to be compatible or contrast with the background. It is similar to Method 2 and although more convenient to the user, it is not likely to be as accurate.



Method 3 for comparing target/background colour compatibility.

- a. A photograph of the site and background is taken. The proposed outline of the building is cut out. Colour strips are placed behind the photograph to represent roof and wall colours.
- b. Alternative colours are tested.

Photographs are taken of the proposed site including the background, from each significant vantage point. The approximate outline shape of the proposed structure is cut out of each photograph. Combinations of colour strips are placed behind these photographs to represent roof and wall colours. The roof colour strips should be darker.

Each combination colour is then inspected for compatibility against the photographed background. (as in Method 2).

The most appropriate combination is then selected.

Again it is desirable, if at all possible to repeat this exercise in different seasons, so that the seasonal variations in background colours are accounted for. But it is most likely that the limited time available will force assumptions to be made on the probable seasonal colour changes which will occur.

Although this method, unlike Method 2, does not require the use of reasonably large sized areas of known colour, it won't be as accurate either. In general, the larger the colour samples used, the greater the accuracy in comparison. But the main reason why Method 3 is likely to be less successful in use, is that there is no guarantee that the colours represented in the photograph will be accurate. Therefore, the comparison between photographed background colours and unphotographed colour strips, may not truly represent the actual colour relationship between the proposed structure and its background.

Providing you can acquire the larger sized areas of known colour, or have them painted, Method 2 is recommended because it gives a bigger range of alternatives to select from than Method 1. Also, the chosen colours are more likely to be suitable than those chosen through using Method 3.

THE APPLICATION OF COLOUR TO SPECIFIC STRUCTURES

Once the reflectivity of the predominant background colours has been established, it is a simple matter to select a compatible colour for the structure. Alternatively it is a simple matter to pick colours so that the structure becomes a new centre of visual attention in the landscape. It is now time to consider how those colours can be most effectively applied to satisfy design intentions.

Because each structure and background is likely to have an individual relationship, only general principles can be discussed. These principles are also based on the visual cues already stated. Each will effect the degree of attachment between the structure and its background. This time however, the characteristics of the background are already known and we can concentrate on visually modifying the structure by the manner in which colour is applied to it.

Taken one at a time, the principles based on the visual cues are;

COLOUR AND THE TEXTURE OF SURFACES

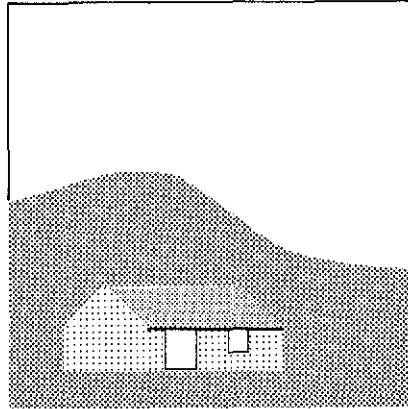
We are concerned with the appearance of buildings in the middle distance where they become landscape elements. At this distance the texture of the landscape background usually is matt in finish. The texture on building components can be reasonably strong to read at a similar distance and give the same effect. For example, most forms of ceramic tile, or standing seam galvanised iron roofing, are quite successful in most landscapes. That degree of texturing may be required to develop visual attachment based on texture. Certainly, high gloss and relatively untextured surfaces should be avoided if compatibility is the design intention. Note that the lighter the colour used on a surface, the more obvious will be the texture. Nevertheless, a compatible colour combination should be found first.

COLOUR AND THE SCALE OF THE STRUCTURE

Where it is the intention to visually reduce the scale of the structure so that surfaces appear to conform with either human dimensions or the background scale, this can be achieved by manipulating either surface colour or surface texture.

Building surfaces which are the same colour and have the same texture tend to look larger in area. Therefore, by subdividing the building surfaces by either means, the overall scale of the surface will appear to be reduced.

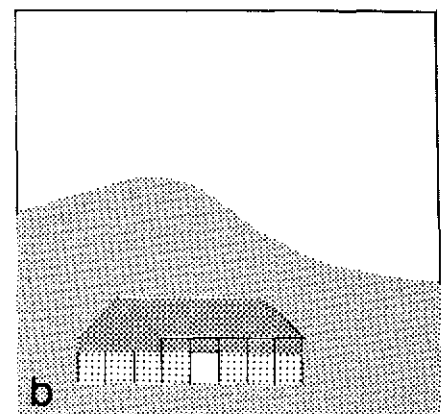
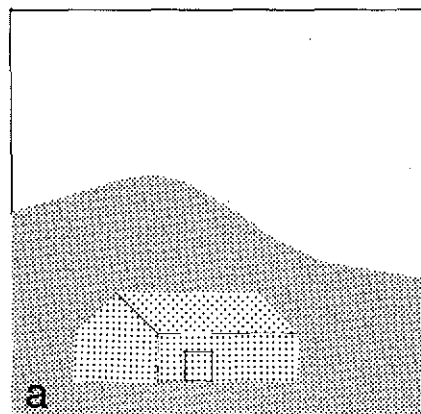
Building elements such as doors, windows and gutters are obvious small scale areas where accent colours may be used successfully and have the desired effect. In such cases, the overall balance of the composition should be considered. Balance is helped by a strong horizontal line between the wall and roof surfaces.



Balance

Even difficultly proportioned buildings may be visually balanced by a discrete use of accent colour.

A change in either compatible colour or material texture on large scale wall surfaces, will serve the same visual function. For example, the darker coloured roof cladding may be brought down the walls to door head height or window sill height, thereby reducing the visual scale of that area.



Colour can be used to visually relate parts of a structure with the human scale.

- a. The doorway suggests surfaces are large and "out of scale".
- b. Surfaces are broken up by colour or texture. They appear smaller and more easily related to the human figure.

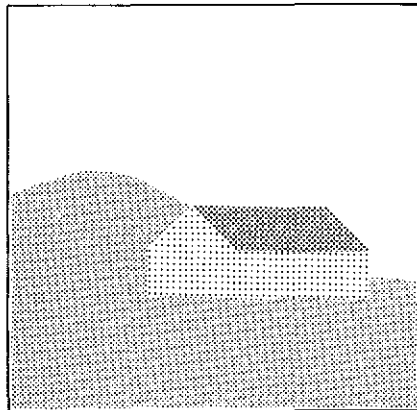
Obviously it is most important to consider the scale of the structure from where it is most likely to be seen. For example, if it will be seen

from above, the scale of subdivision or texture of roof areas will be significant. In this case the more dominant the texture of the roof cladding, the less obvious will be the extent of the roof plane. Generally, the structure will only be seen from the same level (from its floor plane) and the subdivision of its walls is of the only real significance. In this case, the composition of wall elements, such as openings or a series of exposed portal frames, will suggest how the surface can be subdivided. However it is desirable not to change either colour or texture at the corners of the building. The same material or colour carried around the corner, will give the visual impression of 'depth'.

Where it is desirable to increase the scale, building elements within the surface composition can also be accentuated. Strongly textured building materials used vertically, will visually increase height relative to length. Used horizontally they will visually increase the length and apparently reduce the wall height.

COLOUR AND FORM, SHAPE OR PROFILE

It has already been mentioned that if possible, sites on skylines should be avoided to reduce the geometric profile contrast with the organic lines of the landscape background.



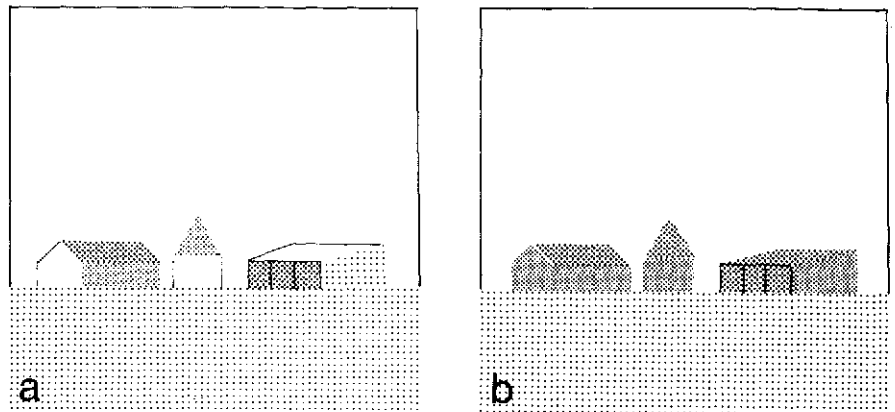
Siting is an important consideration when trying to make a building obtrusive or compatible with its background.

The geometrical building outline contrasts with the rounded landscape background.

The expression of building form by colour is reasonably straightforward. Where a structure is to become a new centre of visual attention, there is usually no problem if contrasting colours or materials are used for different surfaces. Where compatible colours are used however, the attachment between a building and its background is high. This can lead to visual ambiguity unless the compatible colours

used on the structure are of different Hue to the background. In addition, roof colours of significantly lower reflectivity than the walls, (10 per cent difference, or colours usually at least one weight column apart), will help to express the geometric form. There are other means at the designer's disposal. For these refer to "Colour and Directional Patterns", below.

Where the proposed building will be sited adjacent to existing buildings as is commonly the case, it is also likely to be constructed of different materials or be of different form and proportions. Colour may effectively identify the new building with the existing group of buildings. Thus unity and form for the whole group is expressed.

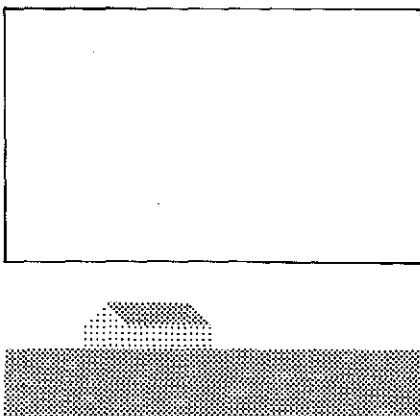


Colour can be used to relate dissimilar building forms.

- a. Structures are unrelated in form, shape and colour.
- b. Colour is used as a theme within the group.

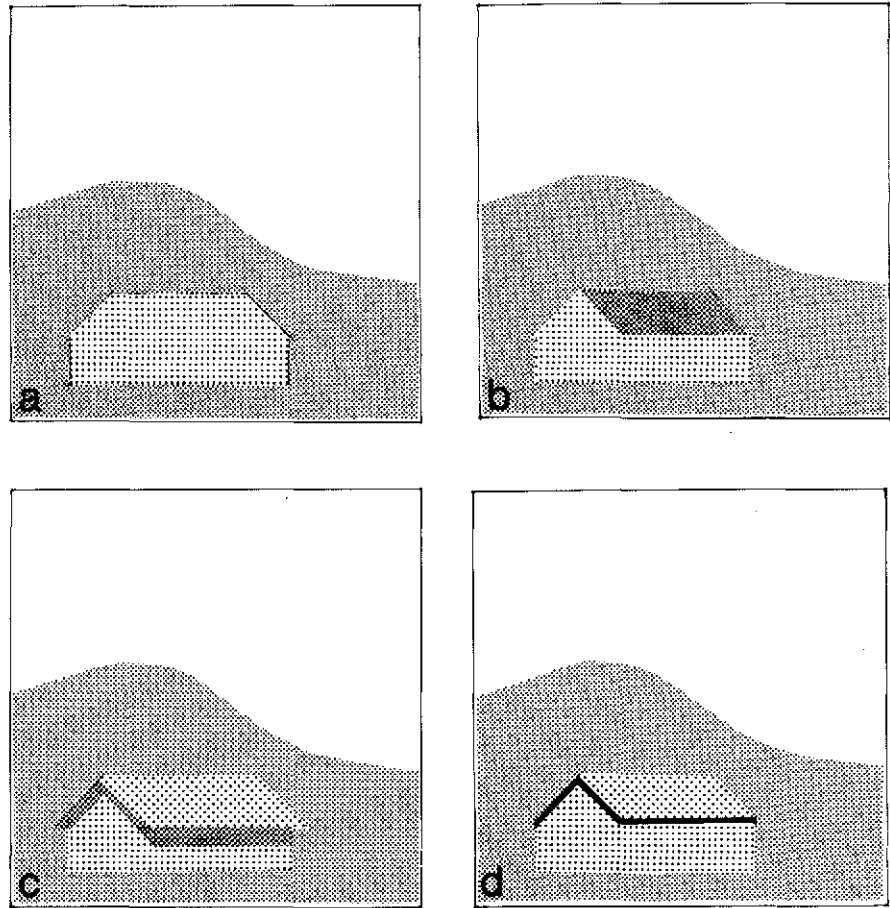
COLOUR AND DIRECTIONAL PATTERNS

Where roofs are darker in colour than walls (or of lower reflectivity), this has the satisfactory effect of tying the building into the landscape rather than associating it with the skyline. This is because the landscape directional pattern is dominantly horizontal. With colours of lower reflectivity on the roof, the roofline and particularly the line at the roof/wall junction, reinforce that horizontal direction and therefore give a greater visual attachment to the background. It has been found that a minimum reflectivity difference of 10 percent is required between roof and wall surfaces to give perceptual definition between those planes.



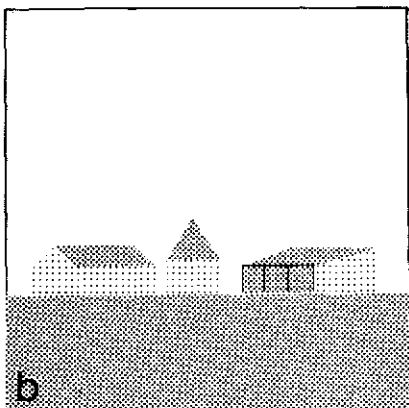
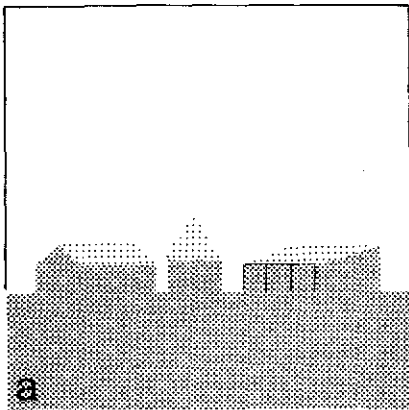
Some combination roof/wall colours are recommended in Part 1 of this study. They are derived from a colour range which lists eight wall colours, with reflectivities of between 12 and 30 percent, and 6 roof colours with reflectivities of between 2 and 6 percent.

There are, of course, other techniques used to visually relate a structure to the horizontal ground line although generally, they are less effective when the structure is seen in the middle distance.



Helping the eye to perceive form.

- a. Visual ambiguity. There are insufficient visual cues to determine building form.
- b. Wall colours or textures are different from the roof. The eye compares the tones and distinguishes form.
- c. A shadow line is created by the slightest roof overhang. This helps to identify the form.
- d. Similarly to (c), the use of accent colour at gutters and gables helps to identify the form.



Darker roof than walls relates to horizontal ground line.

Some visual effects from having lighter coloured roofs.

- (a) Lighter roofs than walls. Roofs relate more to sky. Different gable shapes are accentuated.
- (b) Darker roofs relate more to the ground. The total building shape is more easily seen.

One technique involves construction detailing. Where the roof overhangs the walls, a horizontal shadow line is created. This improves the definition between roof and wall planes and therefore also improves perception of the building form.

Another technique involves picking out the horizontal gutter line in an accent colour. If the remaining line of the roof/wall junction is also picked out in a similar colour, perception of the building form will also be improved.

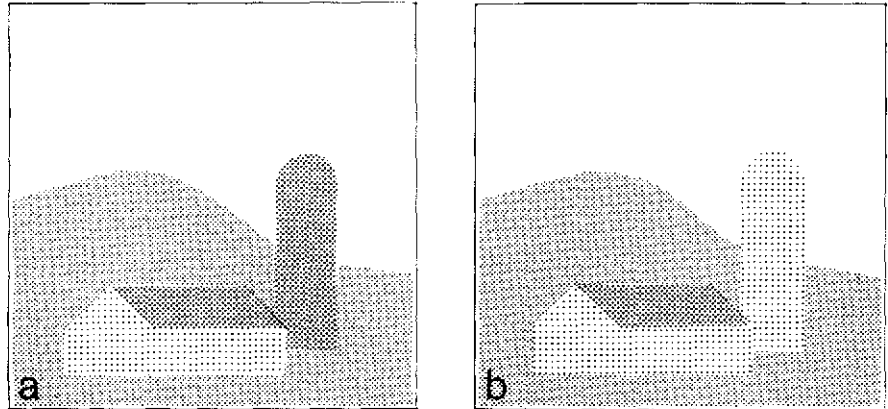
These techniques apply to all buildings whether it is intended they should be compatible with the landscape or become new centres of visual attention within it. It will be noticed that there are many existing buildings where none of these techniques are employed. Complete buildings may be of one material and, one colour, without roof overhangs. Because of the incidence of daylight, the reflectivity off the roof tends to be higher than that off the wall surfaces. We perceive the roof as lighter in colour and consequently, the directional attachment between the building and the landscape is diminished. Sometimes, roofs are deliberately painted in a bright colour which contrasts with the relatively dark walls. Here, roof surfaces tend to lose definition against the bright sky. This combination should be treated with great care. If used on a group of buildings with dissimilar forms and roof pitches, those differences will be exaggerated.

Tower storage silos

This is a particular structure type which deserves special mention because of its distinctive form and increasing use.

These vertical structures are often seen in the middle distance against the ever changing colour and scale of the sky. This presents a difficult visual situation because if colours compatible to the landscape are used on the structure, they will contrast with the brighter sky. On the other hand, if the colours used have a similar reflectivity to the sky they will contrast with the landscape colours. In this situation, provided that the structure is simple in form and has well designed gantries, chutes and ladders then it should be coloured so that it becomes a visual feature in the landscape. This means that it must be sited with particular care and attention within the landscape so that it doesn't conflict with existing centres of attention.

The use of hues which contrast with both the landscape and sky appear to give the most satisfactory result. Avoidance of ambiguity with the landscape can be achieved by the use of higher rather than lower reflective colours. This also prevents excessive contrast with the sky and the more noticeable shadow effect, enhances the cylindrical form.

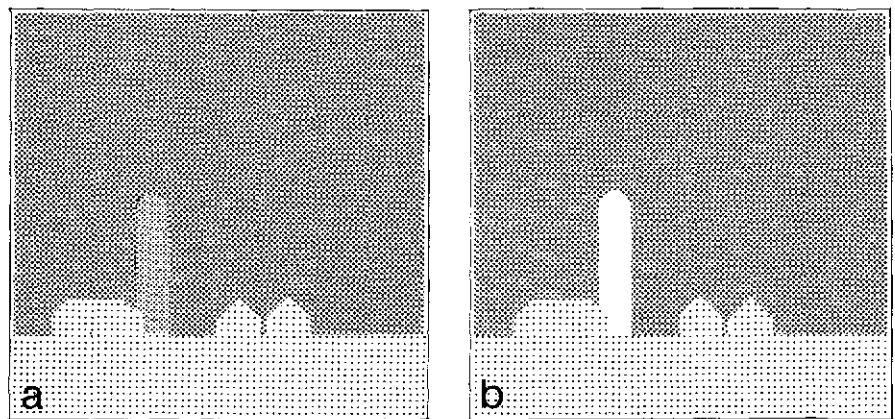


Tower silos and compatible colours.

- a. Silo painted to be compatible with the landscape contrasts with the sky.
- b. Silo painted in medium to high reflectivity colour range is more compatible with the sky.

In this way, a tower silo can also act as a visual focus to a group of buildings in exactly the same way as a church spire visually collects a country town around it.

It should be emphasised however, that the impact of a tower silo can be considerable in a landscape. If it must be sited in a landscape where it is likely to cause some conflict, (either social or visual), it would be wise to seek design advice from a specialist designer.



Tower silos as focus in areas deficient in visual interest.

- a. Silo painted for compatibility with background.
- b. Silo painted as visual focus. It tends to visually group buildings at its base.

CONCRETE WATER TANKS

These structures also deserve special mention because of the number which are to be found in the rural landscape. Very often they are to be found on skylines so that the maximum water pressure is gained. It is recommended that if possible, they should be located slightly below a ridge or hilltop to avoid the contrasting silhouette. It is also recommended they they are either left unpainted, or are painted in colours compatible with the landscape. Generally, their scale in the landscape is not sufficient for them to become centres of visual attention and therefore, a high colour contrast becomes merely annoying.

DECIDING ON COLOURS FOR A STRUCTURE:

SUMMARY OF METHOD

1.0 Decide whether the proposed structure should become a centre of visual attention within the landscape or merge into its landscape background.

1.1 Is the site for the proposed structure deficient in visual interest?

1.2 Is the shape and form of the proposed structure simple?

1.3 Is the overall scale of the proposed structure in keeping with its landscape background.

If any of the answers is 'NO' then the colours for the proposed structure should be designed so that the structure tends to merge with its background and disturb the existing landscape as little as possible. (see 3.0)

If all answers are 'YES' then the structure may be suitable as a new centre of visual interest. In that case, any one or combination of the following visual cues in 2.0 may be used.

2.0 COLOURS FOR A STRUCTURE AS CENTRE OF VISUAL ATTENTION.

2.1 Viewing points and backgrounds:

Select the most obvious places from which the structure will be seen. If the various backgrounds are significantly different, choose the structure-background view most frequently seen or from where the structure is likely to be most obtrusive. Base the proposed colours for the structure on that background and select several roof/wall combinations which are appropriate to it. Then, from these choose that combination which is most likely to be acceptable to all backgrounds.

2.2 Colour reflectivity: By calculation or colour association, approximately establish the reflectivity of the background. Decide whether the colours on the proposed structure should be of higher, or lower reflectivity to give contrast with the background.

2.3 Hue contrast: By colour association, establish the predominant background hues. Can hue contrast between structure and background be exploited?

-
- 2.4 Textural contrast: Can textured contrast be used? Moderate to heavily textured building materials, (e.g. standing seam sheet metal claddings), have a more obvious textured surface when colours of higher, rather than lower reflectivities are used.
 - 2.5 Directional pattern: Check whether horizontal or vertical directional patterns in the structure may be used to contrast with the landscape background. Can these be emphasised with colour
 - 2.6 Subdivision of building surfaces: Check whether wall and roof planes, gutters, windows and doors can be coloured to accentuate pleasing proportions, visually reduce surfaces to a human scale, or give a visual balance to the structure.
 - 2.7 Siting: Check that, by slightly modifying the siting or orientation of the proposed structure, any of the above visual cues will be more effectively utilized. Make sure that the siting does not conflict with existing centres of visual attention.
 - 3.0 COLOURS FOR A STRUCTURE TO MERGE WITH ITS BACKGROUND
 - 3.1 Siting: Check that the siting of a proposed structure doesn't unnecessarily present the geometric structure shape as a silhouette in an undulating landscape. Can the structure be resited to avoid silhouette?
 - 3.2 Viewing points and background: Select the most obvious places from which the structure will be seen. If the various backgrounds are significantly different, choose the structure/background view most frequently seen, or which is the most obtrusive. Base the proposed colours for the structure on that background and select several roof/wall colour combinations which are compatible to it. Then, from these, choose that combination which is the most appropriate to all backgrounds.
 - 3.3 Colour Reflectivity: By calculation or colour association, establish the reflectivity of the background. Colours of the same Weight or Reflectivity should be used on the walls of a building. Check that the proposed roof colour is significantly lower in reflectivity (10%) than the walls.

Alternatively use one of the roof/wall combinations shown in Part One of this study.

- 3.4 Adjacent hue: By colour association establish the predominant background hues. Select an adjacent hue for the structure. Refer back to 'Compatible Colours', for a list of hues.
- 3.5 Building group: Very often a new building will become only part of an existing group of buildings. Check that the new building is related by colour, first, to the existing buildings and second, to the landscape. An opportunity to relate the whole group of buildings to the landscape background by colour may come when building maintenance for the whole group falls due.
- 3.6 Directional Patterns: Relate the building to the horizontal plane; by ensuring that the roof colour is at least 10 per cent lower in reflectivity than the wall colour; or, by using a colour combination shown in Part 1 of this study; or, by creating a horizontal shadow line at the roof/wall junction with a roof overhang; or, by picking out the horizontal roof gutters and roof edge fascias in an accent colour.
- 3.7 Form: Check that the form of the structure will be legible. Any one of the techniques suggested in 3.6 will assist in legibility of form.
- 3.8 Scale: Check the scale of the structure with that of the landscape setting. Check that the scale of the wall surfaces relates to human dimensions. If either scale is too great, consider the subdivision of surfaces by colour, either integral to building materials or applied. For example, small surfaces such as doors, windows and gutters may be given accent colours. Materials of different textures may be used to give a tonal subdivision of surfaces.

USE OF THE DESIGN GUIDE

It is hoped that this design guide will be relatively simple to follow and will be of real assistance to the user. The use of jargon was kept to a minimum but unfortunately any study of colour is reasonably technical by nature. Therefore, where this jargon has been used, care has been taken to ensure that it is based on the most up to date and internationally recognised colour system. The terms used may be new to many people but they now have popular support by most manufacturers.

Finally, if a structure is of particularly large scale, or is sited in a difficult landscape, it is recommended that you call in specialist advice and get an independent recommendation on colours. Most Landscape Architects and Architects are equipped to help in those situations.

Colour for Structures in the Landscape

Part 3.

A methodology for colour derivation in
the New Zealand rural landscape

3

A METHODOLOGY FOR COLOUR DERIVATION IN THE NEW ZEALAND RURAL LANDSCAPE

INTRODUCTION

This part of the study describes for designers and planners the aims of the general colour survey conducted throughout the rural landscape. It describes the methodology used and the general results achieved. It refers to the construction of a limited colour range from those results. Lastly and most importantly, it outlines a framework within which alternative general or local surveys may be conducted.

Landscape colour survey

PRACTICAL AND THEORETICAL BACKGROUND

The preface describes the visual problems arising from the siting of large scale modern structures in the rural landscape. Too often they appear unintentionally obtrusive in their setting. But structures are required at a cost which can be afforded and at a scale which will accomodate changing agricultural and industrial techniques. Therefore the use of surface colour was investigated as a practical means whereby the impact of a structure could be minimised.

Studies in the field of visual perception indicate that the colour relationship between a structure and its landscape setting, is a 'target-background' situation. Before that relationship can be manipulated through using different colour combinations on the structure, the colour characteristics of the background have to be known.

TIME OF SURVEY:

Following that reasoning, a countryside survey of the rural landscape was conducted. Ideally it should have spanned one complete year in many different locations. Seasonal variation in vegetation types and local colour eccentricities will obviously influence the results. Unfortunately neither the time or money was available to do this. Therefore the survey was conducted in spring and the findings for the landscape colour characteristics were weighted so that hypothetical annual characteristics could be assumed.

LANDSCAPE COMPONENTS SURVEYED

Three distinct components of colour in the rural landscape had to be surveyed.

First; vegetation colour and the most likely seasonal colour changes.

Second; surface geology colour and the area of soil visible due to agricultural activity.

Third; the effect of changes of the characteristics of incident daylight and sunlight on the colour appearance of the landscape.

Before the field survey commenced a preliminary study was made of the characteristic colours for topsoils, subsoils and rock types. The Munsell Soil Colour Book was used. Pedologists and geologists helpfully indicated the approximate colours for the dominant types in each category. However, the results were only useful as indicators. Pedologists are rarely concerned with dry soils as seen in the landscape. Usually they are concerned with the colour appearance of moist soils - certainly never with the textural effect on soil colour given by a ploughed surface. Similarly, geologists are concerned with the unoxidised colour of rocks, not the oxidised colours as seen in the landscape. Oxidisation greatly effects the colours of most rock types. Therefore, the results of this earlier study were treated with circumspection. The results of the field survey were considered to be far more reliable.

LANDSCAPE COLOUR CHARACTERISTICS SURVEYED

The first problem was to decide which colour attributes should be looked for in the landscape so that colours could be reasonably accurately specified. It was found that those attributes were embodied in the standard, BS 5252 : 1976. (1)

To prevent confusion over the terminology used, a brief account is given of the developments leading to the formulation of the standard.

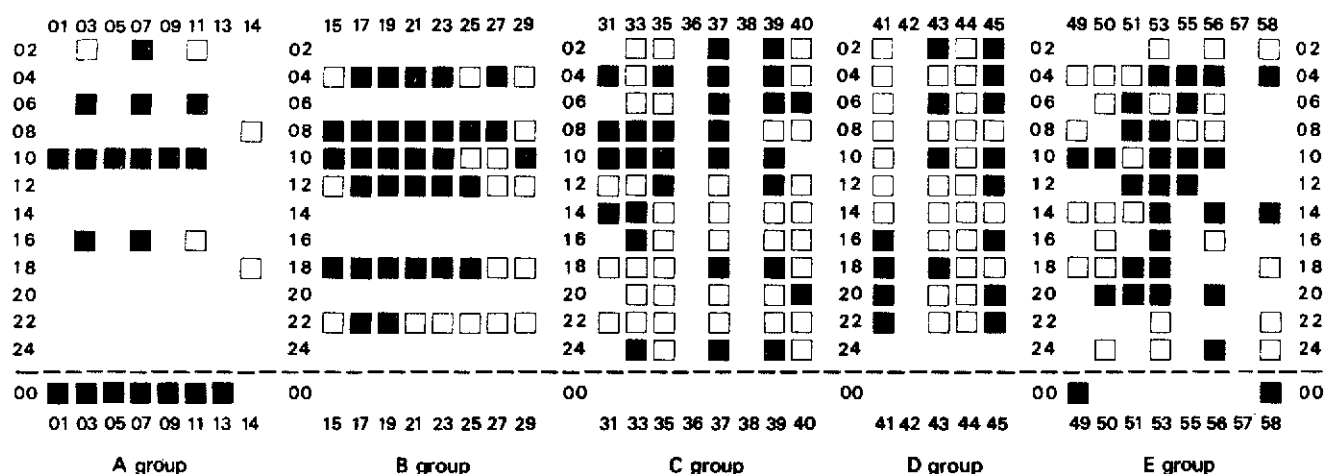
In 1972 the British Standards institution published a Draft for Development (DD17) entitled 'Basic Range for the Co-ordination of Colours for Building Purposes' (2)

From this framework, eight eight colours were selected to form the colour standard BS 4800 which superseded BS 2660 in January 1973.

Since 1972, the draft (DD17) has been amended and finally modified to form a new standard, BS 5252 : 1976, 'Framework for colour co-ordination for building purposes'.

(1) British Standards Institution
BS5252:1976 'Framework for
colour co-ordination for
building purposes', London, HMSO.

(2) British Standards Institution,
Draft for Development, "Basic
Range for the Co-ordination of
Building Colours", BRE Digest
149 (HMSO, January, 1973).



BS 5252:1976; The colour system used

The standard consists of a framework within which 237 colours are systematically related to each other in terms of the three visual attributes, 'Hue', 'Greyiness' and 'Weight'. (Note that these terms are used in the operative BS 4800, British Standard Colour System and should not be confused with the Munsell terms, 'hue', 'value', and 'chroma' used in the withdrawn BS 2660 British Standard Colour System).

HUE

HUE is the colour attribute of redness, yellowness, blueness etc.

The framework has twelve horizontal hue rows in spectral sequence, plus a further row of neutral colours (i.e. without hue). They are designated by two numerals ranging from 02 (red purple) to 24 (purple).

GREYNESS

GREYNESS is the estimated grey content of colours.

The framework divides the colours into five groups lettered A to E, representing steps of diminishing greyiness. For example, Group A is grey; Group B, nearly grey; Group C, grey/clear; Group D, nearly clear; Group E, clear.

WEIGHT

WEIGHT is a subjective term for lightness, modified as necessary to produce colours of the same character in different hues.

The framework provides up to eight columns of colours of equal weight in each greyness group. In fact there are 38 columns shown of equal weight. Columns are numbered from the left-hand column of A Group (01) to the right-hand column of E Group (58).

THE COLOUR NOTATION USED

Each colour is identified by a code which indicates its position in the framework. The code consists of three parts, the first signifying Hue; the second, Greyness; the third, Weight.

Hue is signified by an EVEN NUMBER with two numerals, e.g. 02, 04, 24 etc.

Greyness is signified by a LETTER e.g. A, B, C, D, or E.

Weight is signified by a NUMBER with two numerals, e.g. 07, 19, 58 etc.

Example: 10 B 29 : Hue row 10, Greyness Group B Weight Column 29. Colours of the same row, or greyness group or weight column have the same respective colour attribute.

Appendix 'A' of BS 5252 : 1976, relates the approximate Munsell references to the above notation.

Reflectivity

AN IMPORTANT COLOUR CHARACTERISTIC

Although the attributes of Hue, Greyness and Weight will accurately specify a colour, another colour characteristic must be mentioned because sometimes it varies with all three.

The "Reflectivity" of a colour describes its ability to reflect light. It will be remembered that "Weight" is also related to the lightness or darkness of a colour. Hence it is related to reflectivity. However some weight columns, in Greyness groups C, D, and E, contain colours of equal weight but different reflectivity. The two are not synonymous.

Reflectivity is important for the following reason.

As this study is concerned with the colour relationship between large structures and their backgrounds it was necessary to limit the survey to the colour appearance of the landscape from

the middle - far distance. At this distance a structure becomes a landscape element with a background relationship.

Also at this distance, the colours of plants, leaves and flowers tend to merge into an overall colour appearance. There is a minimum of noticeable texture and the colour appears to be uniform.

Textural effect on a structure is also diminished and the most likely contrast between the structure and background is likely to be one of colour. This assumes that the shape of the structure will become less distinct as its colour tends towards that of the background.

It has been found that the most important characteristic of colours seen in the middle-far distance, is reflectivity. The greater the difference between the reflectivity of colours on the structure and the colour of the background, the greater will be the contrast between them and vice-versa

On the survey, the reflectivity of landscape colours was not directly recorded but was calculated later as a percentage. Refer to BS 5252 : 1976, Appendix 'A', for the calculation procedure.

Equipment used on survey

(a) BS 5252 : 1976 range shown as small patches on one card.

(b) Epidiascope, as shown in diagram

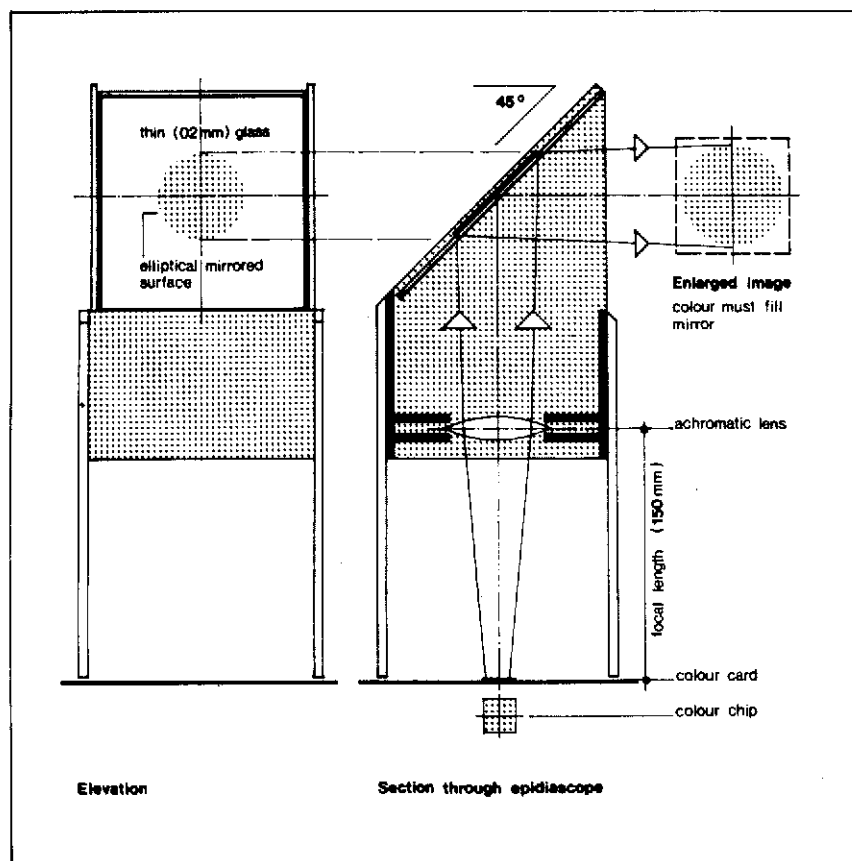
The BS 5252 range has the advantage of using an up to date standardised colour notation. It can also be related to the BS 4800 range. Appendix 'A' of BS 5252 supplies the superseded 'Value' (lightness) reference for each colour so that its reflectivity can be calculated.

It also has the advantage, that it includes a finite range of colours making it easier to select a limited range of typical landscape colours appropriate for the use of manufacturers.

The BS 5252 range also has disadvantages. The colour patches are too small for effective direct comparison with landscape colours. All the patches are on one card and the colours consequently suffer from interference from each other and the white card mount. It will be shown that these disadvantages were overcome by the construction of an epidiascope. Otherwise they may be overcome by acquiring the companion standard, BS 5252 F, which is a colour matching fan of larger coloured patches.

The 237 colours offered in the BS 5252 range, give only reasonable opportunity to match landscape colours. But as its name suggests, ('Framework for colour co-ordination for building purposes'), this standard was not designed for the use to which it was put in this study. Consequently for some groups of colours found in the New Zealand rural landscape, it is not suprising that the range is deficient.

At the time of the survey BS 5252 : 1976, was relatively expensive and not readily available. Both situations are likely to change in the near future as it is likely to be commercially produced in New Zealand.



Epidiascope constructed for comparing colour sample in the landscape with colours in BS 5252 : 1976 colour range.

The Epidiascope was constructed as shown in the diagram. It was built specifically to overcome the problems of small colour patch size and colour interference. It also had other advantages. The card showing the colour range could be horizontal, (thereby approximating the landscape surface and having the same incident daylight upon it), yet the colour image which filled the mirror, on the half mirrored surface, was upright. This meant that the colour of the image could be directly compared with the colour of the landscape beyond.

Bearing in mind the limitations of the BS 5252 range - the area covered by the survey, the objective of creating only a very limited typical colour range for manufacturing purposes, the complete lack of sophisticated daylight recording equipment and finally the limited time available - it could only be anticipated that we would record the gross order effects of colour occurring in the New Zealand rural landscape. More will be said of this later.

USE OF EQUIPMENT

The landscape background for a hypothetical site in the middle-far distance was selected for colour evaluation. Two criteria were used for determining the distance. First, the hypothetical 'site' should be far enough away for a large structure to be seen as an element in its landscape setting. Second, the hypothetical site should be close enough for a large structure to make a significant visual impact. In this way, the middle-far distance was loosely defined between two general parameters.

The BS 5252 range card was laid on a horizontal surface. The epidiascope was placed on top, directed towards the site, and was then moved from one range colour patch to another, until a good colour comparison with the landscape background was made.

There are three points to note about making the colour comparison. First, care was taken that the incident daylight on the card was not significantly different from that on the landscape background, e.g. the card was not used from inside a vehicle or in the shadow cast by the observer. Second, when comparing the landscape to a colour patch and through the half mirrored surfaces, care was taken to ensure that the reflected image of the colour patch completely filled the mirrored ellipse. Third, when making the same comparison, it was found useful to put the eyes slightly out of focus. This had the effect of reducing the outline and colour detail seen. It also helped to re-state the background textural effects in terms of an overall uniform colour.

Once the comparison had been made, the colour attributes in the BS 5252 range colour were noted.

CONSTRUCTION OF THE SURVEY:

For each colour sample recorded, the site and natural lighting characteristics were noted. These characteristics are discussed so that some idea of the construction of the spring survey is gained.

1.0 Site Characteristics

- 1.1 Site location
 - 1.2 Soil group
 - 1.3 Topography
 - 1.4 Hill slope aspect
 - 1.5 Range
 - 1.6 Subject description and colour
- ##### 2.0 Natural lighting conditions
- 2.1 Time of recording
 - 2.2 Clear sky : Sun location
 - 2.3 Overcast sky: 'Illuminance'

1.1 SITE LOCATION

It was assumed that a greater number of large structures would be erected in rural areas of higher population density. Consequently, because they would be likely to be seen more often by more people, their visual impact could be quite considerable.

Structures erected in areas relatively free of modifications due to the influence of agriculture or forestry etc., will still have a potentially large impact because of contrast. However it was felt that structures erected in such areas, (especially those in national parks), would be more likely to have individual design attention.

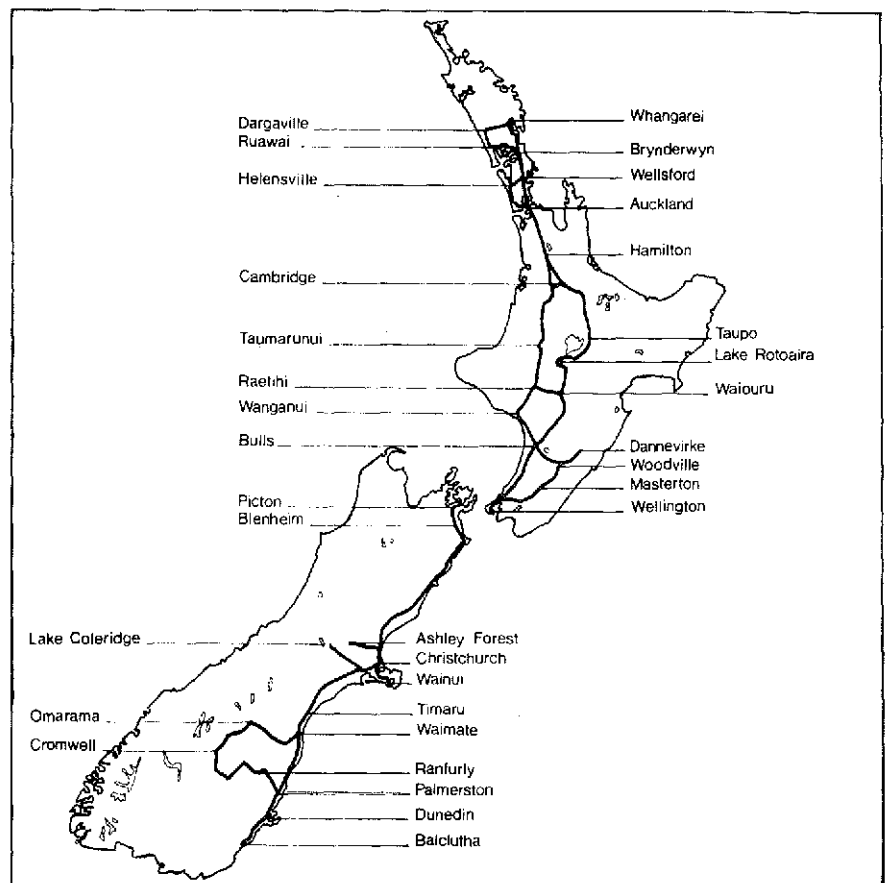
Therefore, locations in the more densely populated lowland and agricultural areas were given emphasis. Colour samples were generally taken from major roads, as these offered the most likely vantage points to the greatest number of people.

Over 80 per cent of New Zealand's agricultural land is in pasture. Therefore the greatest part of the survey was concerned with land in that use. Naturally, the associated windbreaks and hedgerows were considered as complementary to that use.

Land used for cropping, was only superficially surveyed, not only because of its relatively small area, but also because of the attendant wide variations in colour over a short time.

Refer to the map showing the routes taken for the spring survey. Available time limited the number of areas it was possible to visit. Those sampled were assumed to be representative of different agricultural landscape types. The routes were

pre-selected but the location of each site was noted at the time of the sample .



Route taken for spring sample of colours in the New Zealand rural landscape.

1.2 SOIL GROUP

Soil formation is linked to any or all of the following factors; the parent material, its nature and degree of weathering; the vegetation and soil fauna; the topography and slope aspect; the soil forming time; lastly and most important, the climate. Therefore, information on soils is unique as a source of basic data for classifying land uses.

As a consequence, soil types generally describe the broad colour range which can be expected in a locality, throughout different seasons.

If this principle at first appeared to have some possibilities for the selection of areas to be sampled for colour, it also had inherent limitations. The more man-modified a landscape becomes, the greater is the potential for diverse uses and vegetation types. Also, as a generalisation, it does not embrace small scale, local eccentricities. Despite these limitations, it was decided that the selection of sites for colour sampling based on soil groups had some merit, provided that, first,

the areas of distribution for soils were coarsely classified and second, that land uses and vegetation types were seen to be a characteristic within the given area.

It was felt that the soil groups shown in the 'New Zealand Atlas' (3) were appropriately general for this colour survey. Of the 24 groups classified, areas represented by only 4 were not visited. In each case those areas were unimportant to agricultural land use.

The use of general soil groups to define appropriate areas for colour sampling had the advantage that some locations, of similar soil group and land classification types, did not have to be visited.

1.3 TOPOGRAPHY

The topography for each sample was noted on the premise that a topographical variation within a landscape could produce a variation in the colour sample for that area. Slope aspect and steepness influence the effect of incident light on texture and consequently the colour perceived.

Under the category of topography, only the broad classification of 'Flat', 'Rolling' and 'Steep' were noted.

1.4 HILL SLOPE ASPECT

It was thought that this landscape characteristic may more accurately specify soils and vegetation types associated with different aspects.

As the survey progressed, the slope aspect was in fact recorded less and less. It proved to be too specific for a survey of this general order. Nevertheless, a consideration of 'Aspect' may be helpful in colour surveys covering smaller areas.

1.5 RANGE

This study is concerned with structures seen in the middle-far distance, against a landscape background. The colours surveyed had to be seen at that range.

However in the field, such a description of the range is gloriously indeterminate. Therefore it had to be asked before each sample was taken; first, at what actual distance in this landscape will a large structure have a reasonable impact as a landscape element ? Second, at what actual distance does the texture converge to give an overall uniform colour ? Obviously, there was still a fair amount of latitude depending on the topography and the degree of texture. Therefore the range was noted in the broad classifications; 'Medium', 'Medium-Far' and 'Far'.

(3) Ian Wards, ed. New Zealand Atlas (Wellington : Government Printer, 1976) p 138 - 139.

Range is important because of the effect of atmospheric haze on colour.

1.6 SUBJECT DESCRIPTION AND COLOUR

Lastly the area sampled was described in terms of subject matter. (e.g. vegetation types and colour, top or sub-soil colour etc.) There were usually several readings for the one site.

Readings for one sample may be as follows;

Bracken, 08 C 39

Pastures, (rough) 12 C 37

Bush, (mixed podocarps) 10 B 29

If a particular subject had no one colour match on the reference card, the closest likely colour combination was bracketed.

e.g. Soil in cutting, 08 C 37/ 08 C 39

2.1 TIME OF RECORDING

The quality of natural lighting also had to be recorded.

There is considerable variation in light quality throughout the day and year due to the path followed by the earth relative to the sun. Variable angles of incident sunlight on the earth's surface will not only influence the textural effect on the surface, but because the sunlight passes through different atmospheric layers at different times, the colour component of sunlight also changes. For example, low altitude sunlight tends to degrade all colours seen in the landscape except red.

The most extreme effects were eliminated from the survey by restricting the recording times for colour sampling to hours when the sun was well above the horizon. Generally, no samples were taken before 9 a.m. or after 5 p.m. (Survey conducted in October).

It had been intended to calculate the sun angles for each recording to try and establish the effect of incident light direction on colour. This was not done, as it was thought that such calculations presumed a degree of accuracy which did not match other survey techniques used.

2.2 CLEAR SKY : SUN LOCATION

It was noted that texture in the middle distance altered the colour seen. This colour variation depended not only on the angle of the sun above the horizon, (and the degree of texturing), but also on the position of the sun relative to the observer. For example it was not uncommon for colour samples taken facing the sun to be darker than samples taken with the sun behind. When the topography and vegetation types were similar for those recordings, it was concluded that this difference in light reflectivity was due to the

position of the sun and the shadows visible. Therefore, the relationship of the sun to the observer was generally recorded as, 'Sun in front', 'Sun at side' or 'Sun behind'.

2.3 OVERCAST SKY : 'ILLUMINANCE'

On this survey, only general colour information was being recorded. Therefore only lighting effects of a gross order were likely to influence the colours recorded.

'Illuminance' or the amount of light falling on an object, (flux per unit area), was not measured but assessed in more general terms referring to the daylight conditions. These were 'Poor', 'Medium', and 'Bright' similar to those used on simple cameras. (For overcast conditions, the direction of the light source is of little consequence).

In fact the survey was conducted over a time when there was a fairly even distribution of lighting conditions ranging from sunlit clear skies, to bright, medium and poor lighting for overcast conditions.

(4) Edwin H. Land "The Retinex Theory of Colour Vision" *Scientific American*, (December, 1977), pp 108 - 128.

Edwin H. Land, (4) recently found from laboratory experiments, that objects retain their colour identity under a great variety of lighting conditions. He further found that colour can be correlated with the reflectivity of an object and independent of "radiant flux", (the rate of flow of luminous energy). It seems that the eye automatically adjusts to light levels, so that colours in the landscape can be assessed with some consistency under different levels of illumination. But there is one important difference between Land's laboratory experiments and a colour survey in the landscape. He was not concerned with the effect of texture on colour - we were ! Therefore in the survey, a clear distinction was made between clear skies and directional sunlighting, (emphasising textural relief), and overcast skies with non-directional lighting, (where textural relief is not as obvious).

SPRING:HUES

A vast majority of the hues occurred in only three of the twelve hue bands available. These were;

(08) Yellow-Red

(10) Yellow

(12) Green-Yellow

These hues fairly represent the pasture, bush and scrub content of the landscapes sampled.

Of the trees, Cupressus macrocarpa and Pinus radiata were the only well represented species which regularly appeared in the (18), Blue hue band and outside the three dominant bands.

(refer to the survey graph)

It was somewhat suprising that the (14) Green hue did not occur to any significant degree in the rural landscapes surveyed.

SPRING : GREYNESS GROUPS

Most spring colours occurred in the middle three of the five greyness groups. These are the B, C and D groups, where colours aren't saturated with grey but nor are they completely clear of it. It was found that in B group, (nearly grey), soils, rocks, tussock, bush, gorse, broom and the eucalypts were well represented. C group, (grey/clear) predominantly contained pasture types, willows, some of the poplars, hawthorn and native bush. D group (nearly clear grey), included the improved pastures.

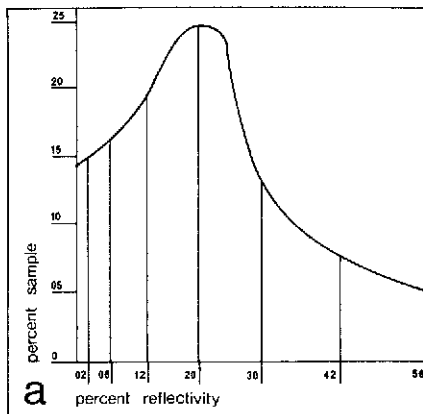
SPRING : WEIGHTS

High weight colours did not occur in important large areas when seen in the middle distance. Even pastures containing a high percentage of buttercups in flower were not conspicuously different at that distance. Exceptions were gorse and broom in flower which, because of high colour contrast between the flowers and stems, demanded combination readings.

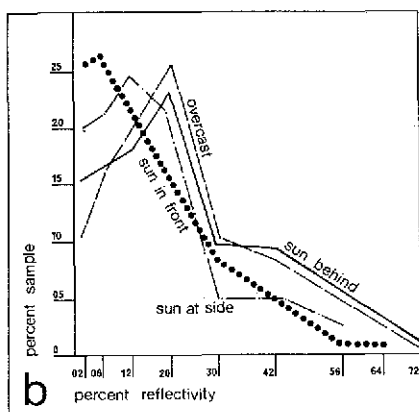
Of the total range of weights it can be seen from the graph that the most common were from (17) to (45) inclusive, with some emphasis on the darker or heavier weight colours in each greyness group.

SPRING : REFLECTIVITY

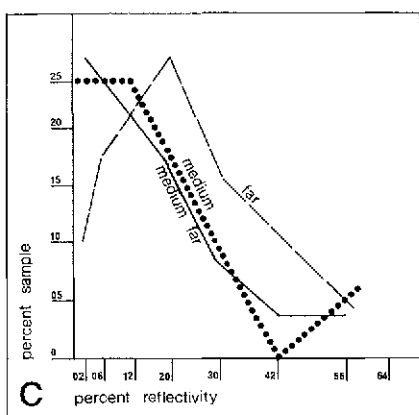
The reflectivity was calculated for each colour sampled. It was found that although ninety percent of the readings occurred between 2 and 56 percent, the shape of the graph indicated that the bulk were included in the range between 2 and 30 percent. The maximum number of readings were of 20 percent reflectivity. See graph (a).



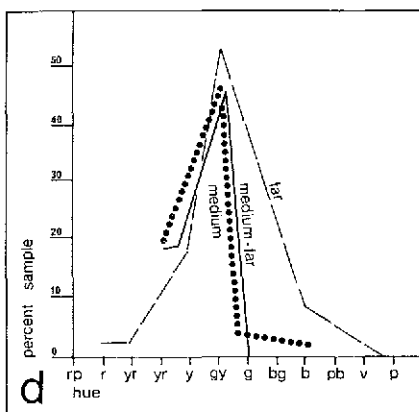
The reflectivity curve for the spring colour sample throughout the rural landscape of New Zealand.



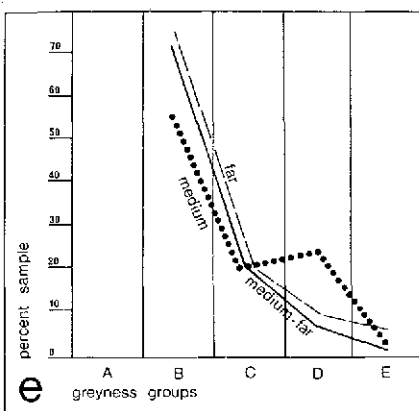
Reflectivity : the effect of natural lighting direction on reflectivity.



Reflectivity : the effect of distance between observer and subject on reflectivity.



Hue : the effect of the distance between observer and subject on reflectivity.



Once the general results for hue, Greyness, Weight and Reflectivity were known, other site and lighting characteristics were related to them. But note that the small scale graphs are shown for interest only. Because of the general nature of the survey, the equipment used and the variables involved, only broad inferences can be drawn from those graphs.

NATURAL LIGHTING CONDITIONS/PERCENT REFLECTIVITY

It will be noted from graph (b) that when the sun is in front of the observer, the percent reflectivity of the sample is significantly lower. Curves depicting reflectivities for the sun behind the observer and for overcast conditions, show a good correspondence. In both cases, textural or shadow effects are less likely to be obvious.

DISTANCE/PERCENT REFLECTIVITY

Refer to graph (c). While curves showing the reflectivity for colours in the medium and medium-far distances show good correspondence, the reflectivity for colours in the far distance is significantly higher. This can be attributed to the colour effects of heat haze, or dust particles suspended in the atmosphere and reflecting sunlight. Because of this variation, the distance of the sampled landscape from the observer is quite important.

DISTANCE/HUE

Refer to graph (d). It will be noted that about 50 percent of the readings for each distance, appear to occur in the Yellow and Green-Yellow hue bands. For the far distant readings however, there is also a significant percentage of hues in the bands ranging to Blue-Green and Blue. This optical effect is well known.

DISTANCE/GREYNESS GROUPS

Refer to graph (e). Generally the curves show a good correspondence of the Greyness Group to each distance. The aberration of the medium distance curve in greyness group D, is due to the high content of pastures sampled at that range. Note that of the middle three greyness groups, colours in group B were the most prevalent over all distances.

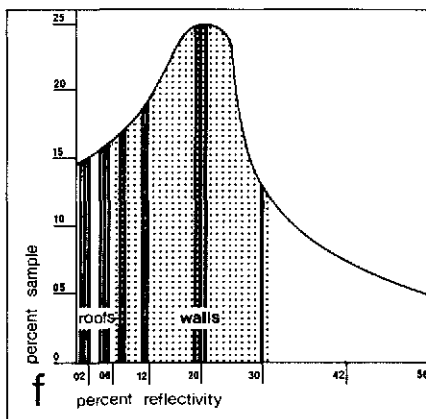
Greyness : the effect of the distance between observer and subject on greyness.

DERIVATION OF LIMITED COLOUR RANGES FROM RESULTS

Spring range

(A) SPRING RANGE; by direct derivation.

First it was estimated that a limited colour range should include no more than fourteen colours, (eight for walls, six for roofs), if it was to be useful to manufacturers. Because of the necessity of having colours of at least ten percent difference in reflectivity between roofs and walls, (see Part 2 of this study), the typical reflectivity range derived from the survey was broken into two parts. Colours of between 2 and 6 percent reflectivity were considered suitable for roofs while those colours between 6 and 30 percent reflectivity, were considered suitable for walls.



This meant that any of the six proposed roof colour reflectivities could be distributed proportionately within the amplitude of the spring survey curve, provided that they were within the 2 to 6 percent range. The eight wall colours were handled in a similar manner within the 6 to 30 percent reflectivity range. Refer to graph (f).

From the spring survey, it was found that approximately 50 percent of the colours were in Greyness Group B, 25 percent were in Greyness Group C and less than 25 percent were in Greyness Group D. Therefore of the eight wall colours in the limited range, four should be in Group B, two in Group C and two in Group D. Similarly for the six roof colours, three should be in Group B, two in Group C and one in Group D.

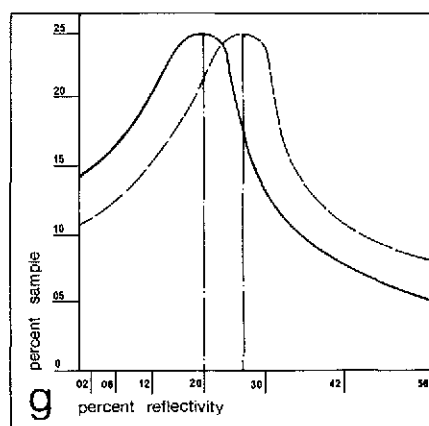
Colour weights were proportioned out in the same manner. But the selection of hues had to be done more subjectively. Care was needed to ensure that the hue distribution did NOT match those hues dominant in the survey. A hue match between a structure and its landscape background, could lead to visual ambiguity. Therefore the hues selected for the range were designed first, to enable their use as adjacent hues to those predominating in the landscape and second, to give a reasonable coverage of the available hue bands. It was hoped this would give a wider colour choice to the user within the controlled framework of the range.

Because of seasonal colour changes in the landscape, a colour range based purely on the spring survey would have limited application throughout the year. Therefore, an annual range was constructed based partly on the spring survey results and partly on the assumed effects of seasonal colour changes.

(B) ANNUAL RANGE; the recommended colour range

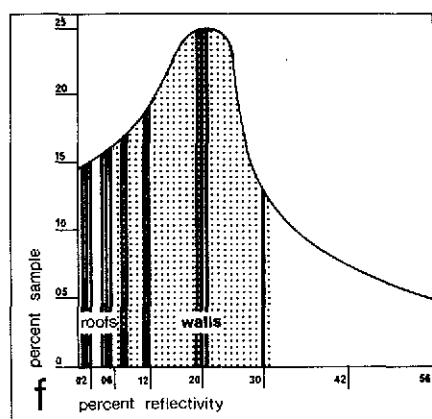
This range is that described and shown in colour in Part 1 of this study. The construction of a limited colour range suitable for annual use was a prime objective of this study.

The annual range of colours is based only in part on the spring survey. Assumptions about seasonal colour changes in the rural landscape had to be made. Each colour characteristic had to be considered independently to gauge in which way and by how much it would vary from the spring results.

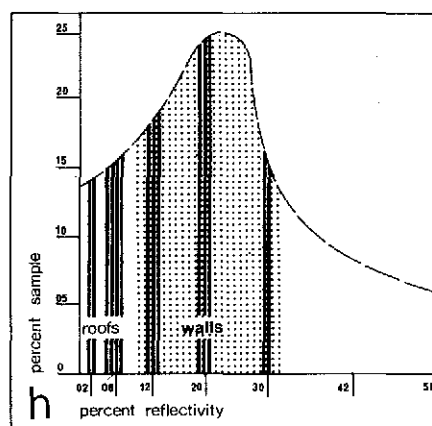


This range is also limited to fourteen colours, eight for walls and six for roofs. It was assumed that the reflectivity of colours, on an annual basis could be slightly higher than that shown in the spring range. This is because of a probable shift in weight to colours which appear lighter over the summer months, especially in the developed and undeveloped grasslands. Graph (g) shows the assumed shift in reflectivity from the spring curve, (solid line), to the annual curve, (broken line).

It was decided that the reflectivity range for roofs (2 to 6 percent) and for walls, (6 to 30 percent) could remain much the same, as long as the colour reflectivities in each category were redistributed proportionately within the amplitude of the assumed annual reflectivity curve.



By comparing Graph (h) (annual curve) with Graph (f) (spring curve), it will be seen that the distribution of possible colour reflectivities has changed. For the annual range there are now two roof colours of 2 percent and four colours of 6 percent reflectivity. For walls there are now three colours at 12 percent, three colours at 20 percent and two colours at 30 percent reflectivity.



Any annual variation in greyness is likely to occur within the Greyness Groups B, C and D. In the summer months there appears to be a drift in greyness for some pasture colours towards Group B. On the other hand much of the new growth on the vegetation sampled in spring, had a colour considerably more clear of grey than the same vegetation would have in winter.

It was decided therefore to use the same greyness representation for walls as is in the Spring colour range, at least until more specific information is available. That representation is; four colours should be in Greyness Group B, two in Group C and two in Group D. However colours for

Reflectivity curves and colour range.

roofs were limited by the requirement that they were of either 2 or 6 percent reflectivity. Therefore four colours had to be in Greyness Group B and the remaining two in Group C.

The attribute of colour weight is related to a colour's reflectivity within one of the greyness groups. Therefore, having made assumptions on how both reflectivity and greyness should be modified from the spring samples to fit an annual colour range, no further assumptions had to be made specifically for Weight.

Hues were selected generally as for the Spring colour range. Where possible, hues adjacent to each of the principal hue bands represented in the Spring survey were selected. It was felt that pastures in many localities would change in hue away from the (12) Green-Yellow band and towards the (10) Yellow and (08), Yellow-Red bands. Some emphasis therefore was given to selecting hues adjacent to those. Of the remaining hues to be selected for the annual range, those which gave a wider choice in the spectrum were favoured, although sometimes the choice was made because of known problems, such as those associated with a structure seen against the sky.

Conclusion

Finally, it must be stressed that the Recommended Colour Range is NOT the only one which will be appropriate either, generally to the rural landscape or specifically to one site. Because of this, the method used for its construction has been rather laboriously explained to achieve several ends;

- (1) to encourage criticism.
- (2) to provide a base for modification.
- (3) to provide a framework within which new and more comprehensive studies can be made.
- (4) to provide a framework within which more localised or specific site surveys can be conducted.

Designers and Planners who require a quicker method for evaluating the colours to be used on a building in the rural landscape, should refer to that portion of Part 2 of this study, subtitled, "Colour Design Techniques for Specific Sites, Method 2," and the concluding "Summary of Method".

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